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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

STUDIES ON FOSSIL FISHES DURING THE YEAR 1907[1]

SINCE the establishment of a merciful Concilium Bibliographicum it is not necessary for us either to wait for generous authors to donate separates, or to ransack files of literature to find the annual doings in each of our fields of inquiry. In the field in which I am especially interested, that of the lowest groups of fossil vertebrates, the Concilium will give you the full *récolte* of references and spare you my list of them—and titles in plenty there are in all the groups of fishes, from primitive sharks to the most complicated teleosts. There are papers systematic on the fossil fishes of California, on new sticklebacks, surgeon fishes, prosturgeons, conodonts—there are papers on the anatomy of fossil fishes, acanthodians and placoderms, and there are not lacking references to the descent of the fishes and to the philosophy of their evolution, as in Eastman's monograph on the fossil fishes of New York, Smith Woodward's address before the Paleontological Society, Patten's continued studies on *Bothriolepis,* and Jaekel's remarks upon the "nest" of placoderms which he has brought to light in the Upper Devonian of Wildungen.

But from all these references we can for the present review only those which bear upon the greater problems.

Our first inquiry, in considering the advances in paleichthyology, is whether the

[1] A portion of the address of the retiring president of the Society of Vertebrate Paleontologists, New Haven, December 27, 1907.

past year has unravelled the problem of the origin of the vertebrata. And I fear that we can, as usual, report nothing better than progress. To our infinite regret there have been forthcoming no new results on the Silurian fishes of Scotland, the clan of Thelodus, Lanarkia, Lanasius. We recall, however, Dr. Patten's splendid work in unearthing fins, tail and other structures of the lowly *Bothriolepis,* and the beautiful models which he demonstrated before the Zoological Congress in Boston. Nevertheless, he has not established, it seems to me, his thesis as to an arthropodial chordate. But he has given us valuable perspective as to the position of this very early "fish": for his studies show clearly how remote a cousin was this form to any type of our known chordates. On evidence which he adduces, such as the position of the anus between the horizontal postero-ventrolateral plates, curious little separately set jaws, which may have operated laterally instead of vertically, and in other regards, we can only conclude that *Bothriolepis* belonged to a terminal group, as far, at least, as our living fishes are concerned. By no stretch of my morphological imagination can I see how this carapaced, hinge-spined, and thread-tailed anomaly could have given birth to a line of our real backboned animals.

Important in this connection is a summary of Hussakof which shows in how many regards the group to which *Bothriolepis* belongs corresponds, as earlier writers believed and as later writers denied, to the group of Arthrodira containing such forms as *Coccosteus, Dinichthys* and *Titanichthys.*

In short, we may be dealing in these groups collectively, which are popularly known as "placoderms," with a great line, a phylum or subphylum, of chordate creatures which preceded the types of modern chordates and which in spite of lines of heroically developed tribes, families, genera and species, died out as the modern chordates came into competitive being. They were, I suggest, chordates in which there were misdirected, or more accurately, unfortunate, evolutional tendencies, affecting structures or correlated combinations of structures. These may well have carried the placoderms along successfully to a certain point, but beyond this basis their morphological restrictions did not permit them to go. Thus these creatures may have been chordates which were defective in the substratum of a gill arch type of mouth and they had not, therefore, laid the necessary foundation for the endofacial complex of the higher animals: I mean that the mouth region of these ancient forms had not the capability of attaining the strengthening support of endoskeletal elements, the greater mobility which gill muscles provided, the greater vascular and nervous supply, the fuller channel for sensory impressions: instead, in those pioneer forms, the mouth apparatus was fashioned on a simpler, more independent and therefore shorter-lived plan. Their jaws were strictly dermal elements, and operated by dermal muscles—all in all a mouth mechanism non-homologous with that of the higher vertebrates.

In the great group of the placoderms known as Arthrodira, including such puzzles as *Dinichthys, Diplognathus, Mylostoma* and *Coccosteus* these jaws seem to have run a gamut of adaptive changes: then followed a period of extermination, for we know to-day of no placoderm—cephalaspid, pterichthyid, coccosteid—which passed an undisputed boundary line into the Carboniferous. The ancient tree died and its branches dropped off. But before its extinction some of its members developed curiously specialized forms and structures, paralleling the characters of modern fishes, as though in a final and

supreme "effort" to compete successfully with their fundamentally better equipped rivals.

The recent discoveries of Professor Jaekel have confirmed a prediction—suggestion made nearly a score of years ago—that we should yet find how manifold were the forms of arthrodires during their period of maximum prosperity. He has found in Wildungen, in practically a single spot and in a narrow fossiliferous seam, usually but a few inches thick, no less than twelve genera and fifty species of arthrodires, nearly all of which are new! And paleontologists may well look forward to the publication of his extraordinary results. Here, then, in the uppermost Devonian, close before their extinction, these forms assumed the most varied characters, even bilateral narrowness, in which the form of a swift-swimming teleost was paralleled. I hope, however, that my colleagues will leave this case to parallelism and will not make this creature, the latest and most specialized of the placoderms, the progenitor of teleosts! Dr. Jaekel has, up to the present moment, unhappily, published only an abstract of his results. But they show clearly enough that the forms described are typical arthrodires; and they yield, I believe, no good evidence as to the kinship of these forms to true fishes.[2] Dr. Eastman's recent and careful elaboration of the view (of a score of years ago) that arthrodires are of lung-fish derivation and that a primitive form of the Australian lung-fish (*Ceratodus*) was their progenitor I have already commented upon in SCIENCE. On the evidence especially of the flattened dental plates of a late form of arthrodire, *Mylostoma,* he is convinced of a kinship to the modern forms, and he explains the absence of ceratodonts in the pre-Mesozoic on the ground of the fragmentary nature of paleontological evidence. He neglects, however, it seems to me, to take into account what we do know of the Paleozoic lung-fishes, and these documents are both numerous and important, as Dollo, for example, has pointed out. And he has not evaded the morphological pitfall (it seems so to me at least) of attempting to establish homologies between more or less terminal forms of widely different descent. Indeed it is clear that if arthrodires are descended from a primitive ceratodont, their puzzling allies, bothriolepids and cephalaspids must also be closely related to the same ancestor, but this is difficult even to imagine: for who can fancy, as early at least as in the upper silurian, in which all these forms occur, that even then they could be traced back to lung-fishes essentially ceratodont? Furthermore, if I mistake not, Dr. Eastman believes that sharks are the ancestors of lung-fishes, and in this event, how far back into the Urzeit would our paleontological fancy project to find the origin of our modern fishes? The paleontological record is scored, seamed and scanty, we painfully admit, but I am confident that it is not as bad as all this: if the lung-fishes, arthrodira and their anomalous allies came from a ceratodont ancestor we should certainly have found a trace of it somewhere in the stupendously long interval between the upper Silurian and the Mesozoic. We find, on the contrary, that not merely is this creature absent, conspicuously absent, but that its

[2] Thus there is no new light on the presence of fins and girdles: what he regards as the "undoubtedly demonstrable" hip girdle in *Coccosteus* is to certain morphologists, at least, a very doubtful structure; whatever it be, it is rudimentary in Jaekel's new forms. Nor does his explanation carry conviction as to the under jaw of *Pholidosteus* with angular and articular elements. The former is, I believe, the "interlateral" plate well known in the ventral armoring of coccosteids, the latter probably an articular (detached) process of the central plate. The views of Jaekel as to the position of the Arthrodira can not, however, be criticized in detail in the present paper.

kindred, which are present and even abundant, are more and more shark-like in dentition, fins and dermal defenses the further back we go. To maintain in the face of such evidence that a ceratodont existed in the Urzeit would be, it seems to me, as difficult as, for example, to maintain the probable presence of man in the Jurassic.

The puzzles of primitive sharks have been considered several times during the past year, and I think it is quite safe to say on cumulative evidence that "if the earliest true fish could be found, it would almost certainly fall within the subclass Elasmobranchii."[3] From a recent study on the structures of the lowly acanthodians[4] we have reason to believe that they are allied more closely to the more typical sharks. Their dentition was quite shark-like, with (a few) successional rows of teeth, and their fin structures conform more typically to the plan known in cladodonts. In this connection the evolution of their curious finfold type of fin in different members of this group has been indicated lately by Smith Woodward. Of other structural features in acanthodians we know even details, *e. g.*, in sensory canals and ear structures. As vertebrate morphologists some of us wish we could believe that the acanthodians, earliest of sharks, had a great number of gill slits, but for the present we shall have to content ourselves with the typical selachian number, five: we wish also that we could feel assured that the mandibular arch in acanthodians was segmented dorsally after the fashion of a typical gill arch, as Reis and Jaekel have shown in the Permian *Acanthodes bronni,* but unhappily certain earlier genera (the lower Devonian *Ischnacanthus gracilis, Cheiracanthus murchisoni*) do not have this interesting subdivision of the palatoquadrate, and it may well be, therefore, that in later forms the subdivision is due to fossilization, the cartilage subdividing, owing to weakness from nutrient vessels, etc., at certain definite spots.

An up-to-date classification of the selachians by Tate Regan should here be mentioned[5] which gives interesting notes as to the evolution of the sharks and considers the paleontological evidence.

The chimæroids have been made the subject of comparative study during the past year,[6] and from an examination of their fossils, anatomy and embryology the conclusion is reached that they are to be classed not as ancestral sharks, but rather as a group highly divergent from some early shark stem. The few undeniably primitive features which they possess are heirlooms from some Paleozoic selachian ancestor—features which modern sharks have not as well conserved owing, among other causes, to the elaboration of hylostylism. The nearest living kin of the chimæroids are probably cestraciont sharks.

Important in this connection is the discovery that our pre-Permian "chimæroids," *i. e.*, those antedating menaspids, may have to go by the board. Jaekel's discovery of associated remains of *Rhamphodus,* as Dollo points out,[7] makes it probable that all ptyctodonts, hitherto classed as chimæroids, are in reality highly modified arthrodires!

Our knowledge of the descent of lung-fishes has not progressed perceptibly during the past year—*i. e.*, if we admit that the Arthrodira and early lung-fishes are not related, the view which we have main-

[3] Smith Woodward, "Natural Science," Vol. VI., p. 38.

[4] Dean, "Notes on Acanthodian Sharks," *Am. Jour. of Anatomy,* Vol. VII., pp. 209–226.

[5] Regan, *Pro. Zool. Soc. London,* 1906, pp. 722–758.

[6] Dean, "Chimæroid Fishes and their Development," Monograph 34, Carnegie Institution, Washington, D. C.

[7] *Bull. Soc. Belge de Geol.,* 1907, pp. 97–108.

tained above. Nor has the year seen any notable advances in our philosophical knowledge of the ganoids. Their fin structure alone has been considered critically,[8] and in this discussion the evolution of the "effective fins" shows the relations of ganoids and teleosts.

Nor has the great group of Teleosts yielded far-reaching results during the past year. The paper of Woodward above cited recapitulates the teleostean fins and skeleton from the standpoint of evolutional philosophy. And, in a matter of detail, Hussakof has described a form of surgeon fish which serves to connect the balistids with the teuthids. On the purely systematic side work has been active, but this phase of research our time will not permit us to treat.

Finally, as to the evolutional philosophy which the study of fossil fishes has touched upon, we can only say that orthogenesis keeps presenting itself with significant persistency. There has, however, been no attempt up to the present time to collect these results systematically —and herein lies a harvest for the reflective worker. We should, on the other hand, mention the vast materials unearthed by Jaekel at Wildungen, for in them he maintains, rightly or wrongly, the appearance of an "explosive" or mutational origin of species.

BASHFORD DEAN

[8] A. S. Woodward, *op. cit.*, pp. 276–278.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
SECTION G—BOTANY

SECTION G of the American Association for the Advancement of Science met during the past convocation week at Chicago, all of the sessions, except the vice-presidential address by Dr. D. T. MacDougal, being held in the Botany Building of the University of Chicago. Three sessions were held for the reading of papers, and all meetings were held in conjunction with the Botanical Society of America, so that in no case were two botanical meetings held simultaneously. The attendance varied from one hundred to one hundred and fifty, and over one hundred professional botanists from outside Chicago were present at the meetings. The sessions were presided over by the vice-president of the section, Professor Charles E. Bessey; in the absence of the secretary, Professor Francis E. Lloyd, Dr. Henry C. Cowles acted as secretary *pro tem.*

The following officers were chosen:

Vice-president—Professor H. M. Richards, Columbia University.

Secretary (five years)—Dr. Henry C. Cowles, University of Chicago.

Member of the Council—Dr. F. E. Clements, University of Minnesota.

Member of the Sectional Committee (five years)—Professor R. A. Harper, University of Wisconsin; (one year, vice Professor Charles E. Bessey, resigned)—Dr. J. M. Greenman, Field Museum of Natural History, Chicago.

Member of the General Committee—Professor M. B. Thomas, Wabash College.

The following resolutions were adopted, in memory of Professor Lucien M. Underwood:

WHEREAS: By the lamented death of Dr. Lucien Marcus Underwood, late professor of botany in Columbia University, science has suffered a severe loss and the American Association for the Advancement of Science, particularly the Botanical Section, an active and esteemed member, be it

Resolved, That this society place on record its recognition of his fruitful labors along his chosen lines in the field of scientific research and instruction and its keen appreciation of the stimulating influence of his personal character and scholarly attainments.

The vice-presidential address of Dr. D. T. MacDougal has been published in full in SCIENCE. Abstracts of the technical papers presented follow:

The Past Season's Experiments with Anthracnose-resistant Clover: S. M. Bain and S. H. Essary. (Read by title.)

Some New Cases of Mendelian Inheritance: George H. Shull.

The common garden sunflower exists in two forms with respect to branching. One of these has a single large head borne on an unbranched stem, the other has a number of strong branches which ascend strongly till they reach nearly the same height as the central axis. The branching is shown to be a Mendelian character, dominating completely over the simple-stemmed type. The garden sunflower differs from the wild *Helianthus annuus* in the color of the disk, the former having a yellow disk, the latter a deep purple disk. The disk color likewise constitutes a Mendelian pair with the purple disk dominating the yellow.

In *Lychnis dioica,* purple and white flowers are shown by a large series of crosses to be a Mendelian pair with purple dominant over white. A large number of families of the composition $DR \times R$ showed a range of variation in the number of purple-flowered offspring from 30 per cent. to 65 per cent. in the different families, and when these percentages were seriated they presented a nearly normal variation curve, showing that the assumption that the unlike gametes unite according to the laws of chance is correct. The usual statement that 50 per cent. purple is to be expected in such cases is inaccurate, for according to the law of chance the 50 per cent. ratio can be properly expected only when the number of observations is infinite. When a normal curve is formed with the mean approximating 50 per cent. within the limits of probable error every proper expectation has been fulfilled.

Both *Helianthus annuus* and *Lychnis dioica* are incapable of self-fertilization, and the occurrence of these cases of typical Mendelian inheritance shows that self-fertilization bears no relation to this type of inheritance, though it was first discovered in a self-fertilizing species.

In *Verbascum blattaria,* two forms occur, one with bright yellow flowers, the other with pale, cream-colored flowers, almost white. These forms constitute a Mendelian pair with the yellow dominant over the pale-flowered form. This differs from the behavior of yellow flower color in *Matthiola* (stocks) and *Polemonium,* in which the white has been shown by Bateson and Correns to be dominant over yellow. The yellow of *Verbascum* proves to be a sap color, while that of *Matthiola* and probably that of *Polemonium* also are a plastid color thus showing that Bateson's classification of the color of *Matthiola* on this basis is probably fundamentally correct.

The Prairie Grass Formation of Southeastern South Dakota: Leroy H. Harvey.

The formation is a part of the Ponca Prairie District of Pound and Clements. Its composition is transitional between the mesophytic eastern and xerophytic western prairies. These two groups of elements during post-glacial migration entered from two distinct centers of migration; the former from the southeast by the Missouri Valley route and the latter from the southwest. The prairie is preglacial in origin and is descended from the climatic prairie of Tertiary times which arose in response to reduced precipitation caused by the upheaval of the Rockies at the close of the Cretaceous.

The floral activity of the formation at Yankton, South Dakota, may be recorded in the following five aspects: prevernal, April 1 to about April 25—six species; vernal, May 3 to about May 31—twenty-

eight species; estival, June 1 to about July 7—twenty-one species; serotinal, July 7 to about August 7—thirteen species; autumnal, August 7 to about September 21—twenty-two species. The prairie elements show a marked grouping into layers which correspond with the floral aspects. Overtopped by the autumnal, the sublayers are successively those of the serotinal, estival, vernal and prevernal. There is a marked distinction in the chresard of base, slope and crest in the prevernal, which becomes less marked in the subsequent aspects, approaching equality in the autumnal. As a result the floral covering shows a corresponding difference upon base, slope and crest in earlier aspects; the influence of position gradually declines, the floral covering presenting a striking similarity over the entire formation in the autumnal.

New or Noteworthy Peronosporales: GUY W. WILSON.

In the course of a monographic study of the Peronosporales several problems in specific limitations have arisen, some of which have been solved and are discussed. To these notes are added the description of two new species of *Albugo* and notes on the distribution of *Phytophthora thalictri* and *Peronospora floerkeae,* both of which are rare species.

Both *Albugo triantherœ* and *A. cladothricis* were described from Las Cruces, New Mexico, the former occurring on *Trianthera,* the latter on *Cladothrix.* Both are rather closely related to *A. bliti,* but are distinguishable by conidial characters. The oospore of *A. triantherœ* is also quite characteristic, while that of *A. cladothricis* is unknown. Of the four other species discussed, *Peronospora cyparissiæ, P. rumicis* and *P. hyoscyami* are to be dropped from the list of American species, the first being a mistaken determination of *P. euphorbiæ,* while the other two represent European species with American cognates. *P. rumicis* becomes *P. polygoni* and *P. hyoscyami* becomes *P. nicotianæ,* a species heretofore reported only from South America. *P. arborescens* must also be added to our flora, having been collected in Colorado on *Argemone,* but erroneously reported under the name of *P. corydalis.*

Notes on Cleistogamy of Grasses: AGNES CHASE.

I. The genus *Triplasis* is found to produce late in the season cleistogamous spikelets in small panicles wholly or partly included in the sheaths; specimens of *T. purpurea* (Walt.) Chapman, collected in October, 1907, show a second form of cleistogene, larger than the others, solitary and sessile at the base of the prophyllum.

II. *Amphicarpon amphicarpon* (Pursh) Nash was collected in October, 1907, with perfect grains in the aerial spikelets as well as in the subterranean cleistogamous ones.

Mutations of Rudbeckia hirta: W. J. BEAL.

Dr. W. J. Beal, of Michigan Agricultural College, during the past five years has selected from many thousands of plants, certain peculiar forms, sports or mutations, flowers of some of which he exhibited:

1. A specimen with wide ray flowers, the head four inches across.
2. A large head of flowers with the base of each ray dark purple.
3. A large head with fourteen ray flowers, each quilled or narrow for one fourth inch at the base.
4. A head in which all the rays were tubular or quilled.
5. A head with rays very light yellow.
6. The rays twisted.
7. A very small head with rays about one fourth inch in length.

8. One with center of head green instead of purple.

Plant Zones of the Mountain Lakes in Northern Colorado: Francis Ramaley and W. W. Robbins.

In the Rocky Mountain region of northern Colorado, the lakes of the subalpine and alpine districts are of the morainal type, while those of the montane zone are chiefly meander lakes. Around these lakes zonation is well developed in cases where there is an accumulation of silt.

In a typical morainal lake studied by the writers, there is a *Carex* zone surrounded by a *Salix-Betula* zone. Among the more prominent plants in the former zone are *Dodecatheon* and *Clementsia* besides various grasses and sedges. Mosses occur here also, chiefly *Polytrichum, Mnium* and *Sphagnum.* In the *Salix-Betula* zone there are such plants as *Elephantella, Pedicularis* and a few orchids. This zone is surrounded by a coniferous forest.

A meander lake at about 9,000 feet altitude, showed four zones: (1) *Carex;* (2) *Salix-Betula;* (3) *Dasiphora;* (4) *Campanula.* Still another meander lake (altitude 8,000 feet) had three zones: (1) *Carex;* (2) *Thermopsis;* (3) *Campanula.* Back of these zones in this particular case there is a belt of grassland before the coniferous forest is reached.

Lakes above timber line show no zonation. In all lakes of the montane and subalpine districts, pond weeds occur and yellow pond lilies in many. There is an entire absence of cattail and bulrush vegetation.

It is worthy of note that in general the pondside plants have come down from higher altitudes and the plants of dry situations have come up from lower altitudes. In other words, the mountain mesophytes are largely boreal forms while the xerophytes show austral affinities.

Rock-ridge Vegetation of Northern Colorado: Francis Ramaley and W. W. Robbins.

The sedimentary rock ridges in northern Colorado have a striking appearance due to the considerable dip of the strata and the numerous faults and folds. Sharp escarpments, deep gulches and irregular erosion lines make the country rough and rugged.

A remarkable scrub formation of mountain mahogany (*Cercocarpus parvifolius*) occurs on these ridges, being generally quite dense where there is little soil and frequently stopping as an abrupt line near the foot of a hill or ridge.

At the line of contact between the granites and the conglomerates there is usually a broad lateral valley with rather fine-grained compact soil. This supports a grassland formation with no trees or shrubs. The granite hills to the west have a scattered covering of pines, various shrubs, grasses and perennial herbs. East of the lateral valley are the sedimentary rock ridges with their dense scrub of mountain mahogany and a few scattered pines. In the deep gulches, Douglas spruces and deciduous mesophytic shrubs occur just as in the canyons of the granite foothills.

The rock ridges with much lime in their composition show a very open formation of *Cercocarpus,* the shrubs being often eight or ten feet apart, but on the sandstone the plants make a close stand very difficult to climb through. *Cercocarpus* grows only on a dry, rocky substratum and is replaced by grassland where there is more soil and moisture, while its place is taken by mesophytic shrubs, trees and grasses in moist shaded situations where there is an accumulation of humus.

A careful study was made of one square mile of territory at the contact of the granites and sedimentaries. This territory was mapped and the vegetation charted

so that the more striking differences between granite hills, lateral valley and rock ridges could be seen.

A Preliminary Account of Studies in the Variability of a Unit Character in Œnothera: R. R. GATES.

The most striking character distinguishing the mutant *O. rubrinervis* from its parent *O. Lamarckiana,* is the conspicuous red color present on the petioles and mid veins of the leaves and on the sepals and young fruits of the former. The variability of this red color pattern in the sepals of *O. rubrinervis* has been the main object of study. Painted types of individual buds were used as standards of classes in cataloguing the variability. The variation in the extent of the red on the sepals is definite, forming a reduction series, the color receding from the margin of the sepals and in extreme reduction appearing only as a series of spots along the sides of the median ridge of each sepal, or rarely being wholly absent. By examination of all the flowers of a plant, the mode of the individual may be obtained, and this is found to vary in different individuals. One extreme variant in a culture of 1,000 *O. rubrinervis* plants showed a great increase of the red pigment, which covered not only the whole sepal (including the median ridge, which is otherwise always green) but also the hypanthium. Whether this extreme form will breed true, and how it will behave in a cross, is to be determined later.

The buds of *Œnothera Lamarckiana,* when attacked by a certain insect, produce red pigment as in *O. rubrinervis,* showing that the capacity for pigment production under certain circumstances is present in *O. Lamarckiana* and not that it is confined to certain germ cells only in which it originates suddenly as a new or additional unit character. These and other facts of variation are not in accord with the DeVriesian conception of unit characters in mutation, but may be better explained on another basis.

In all, 1,460 buds from 104 individuals were examined in this preliminary study. A more extensive study of color variations in *Œnothera* is to be made.

Mine Fungi: PERLEY SPAULDING. (Read by title.)

The Loco Investigation: C. DWIGHT MARSH. (Publication reserved.)

Crystal Formation in Cultures of Penicillium: ARTHUR W. DOX. (Presented by Charles Thom.)

In cultures of different species of *Penicillium* upon Cohn's medium, the formation of peculiar crystals was noticed. Crystals were formed only by those organisms which gradually changed the reaction of the medium from acid to alkaline. Chemical analysis showed them to be magnesium ammonium phosphate with six molecules of water. This substance has heretofore been obtained only by precipitation and in microscopic crystals, whereas the crystals formed in Cohn's solution were often two centimeters in length. The finest crystals were obtained when the culture was carefully maintained at a uniform temperature. This work suggests a possible application of mold cultures to the formation of other substances in crystals, particularly those substances that are soluble in acid but insoluble in neutral solutions.

Embryo-sac Development and Embryology of Symplocarpus fœtidus: C. O. ROSENDAHL.

The inflorescences of *Symplocarpus fœtidus* are borne as lateral branches in the axils of the leaves on the upright, monopodial rhizome. They develop very slowly and the rudiments of the flowers are

distinguishable eighteen to twenty months before the time of blossoming. The ovules are formed during the late summer and fall months of the year previous to blossoming. In nearly all cases the ovary is one-chambered, with but one ovule in each chamber. This is orthotropous and pendant from the upper part of the cavity. Occasionally two chambers are found with one or more ovules in each.

A single archesporial cell is differentiated, which becomes the spore-mother cell. This, by two successive divisions, gives rise to four megaspores. In most cases the two megaspores toward the chalaza end lie in the long axis of the ovule, while the two toward the micropylar end lie transversely. All four spores germinate, the innermost one giving rise to the embryo-sac, the others breaking down.

The first divisions of the oospore are transverse and a row of three to four cells is built up before anticlinal walls appear.

In the development of the endosperm a period of free cell formation is followed by the appearance of cell walls whereby a tissue is built up throughout the embryo-sac. It grows rapidly and soon begins to encroach upon the inner and outer integuments and finally begins to push back into the basal tissue of the ovule.

The antipodal cells give rise to a tissue made up of a considerable number of cells with greatly enlarged nuclei.

The proembryo undergoes rapid changes, at first becoming club-shaped and later on pyriform or ovoid. A short suspensor made up of several rows of cells is formed. Upon one side of the embryo, near the suspensor, a small depression appears which deepens into a groove. On the axial side of this groove the leaves and plumule are differentiated. The axes of the plumule and the radicle form a somewhat acute angle with each other, the one being bent back upon the other.

During the differentiation and development of these structures, the protocorm has completely devoured the endosperm and all traces of the integuments have disappeared. The only ovular tissue left is a small remnant on one side of the naked, nearly spherical embryo.

Regeneration in Root-tips of Vicia and Phaseolus: C. H. Shattuck.

This paper gives the results of the writer's recent experimental work at the University of Chicago. The important points developed by this study are as follows: (1) The lysigenous breaking down of the plerome cells above the point of wounding; (2) the fusion, at certain levels, of young cells from opposite sides of a split root-tip in the region of the pericycle; (3) the disrupting of these tissues at lower levels, thus giving rise to two distinct roots; (4) the complete restoration of the circular form of the root by means of a radial meristem in which the ordinary transverse orientation of the cell plate becomes longitudinal; (5) the encircling of stems by a whorl of new roots when spirally cut through the pericycle; (6) that the root orients itself geotropically, not because the vegetative point has reached a particular stage, but always because of the appearance of statolithic starch and fails to regenerate if this does not appear.

Notes on Gymnosporangium macropus: F. D. Heald.

Gymnosporangium macropus has been considered an annual, but the investigations carried on by the author in Nebraska have shown that two years is required for the "cedar apples" to reach maturity. Young "cedar apples" can be found nearly a month before the rust spots on the apple leaves have matured any

æcidiospores. The unusual prevalence of "cedar apples" in Nebraska is due to the extensive use of the cedar as an ornamental tree and for orchard wind breaks with the planting of varieties of apples especially susceptible to the disease. During the past season, æcidiospores were found in viable condition during July, August, September and until October 22, and it was shown that spores from this period produce no evident infection until the spring of the next year when growth is resumed and the young "cedar apples" become visible.

The Bud-Rot of Carnations: F. D. HEALD.

The bud-rot of carnations is a new disease which has only been prevalent in Nebraska and a number of other states during the past few years. The disease has been proved by the writer to be due to a definite species of fungus, *Sporotrichum anthophilum* Peck, which has associated with it a new species of mite, *Pediculoides dianthophilus* Wolcott, as a constant accompaniment.

The disease affects the buds in various stages of maturity and produces a rotting of the petals and other flower parts, at least the parts enclosed by the calyx, thus interfering with the normal opening of the flower. The disease has therefore been termed the "bud-rot" of the carnation.

A Principle of Elementary Laboratory Teaching for Culture Students: CHARLES H. SHAW.

Biological laboratory teaching in general comes far short of accomplishing the results expected. On the average the student develops relatively little of that interest in the subject and power of observation which are the chief reasons for the existence of such courses.

A teacher is likely to find himself able to stimulate a greater degree of interest and effort in part of the lessons than in others. This fact is of primary importance. Laboratory courses should be made up of those lessons in which the teacher finds himself able to bring the class to its maximum of independent effort, leaving to lecture and demonstration the task of keeping the course logically connected and rounded out.

A sort of corollary to the above seems to be that courses are to be modified in the direction of physiology. To reach the desired end it may in some cases even be necessary to omit certain standard topics of morphology. In all cases the goal must be kept clearly in view and any needful sacrifice made without limitation.

The Influence of the Form of Carbon upon the Morphology of Penicillium Cultures: CHARLES THOM.

Cultures of eleven species of *Penicillium* are presented to illustrate the wide difference in morphology produced by changing the source of carbon in synthetic culture media. For comparison the species are exhibited upon potato-agar, then upon synthetic agar in which carbon is presented: (1) as granulated sugar (sucrose), (2) lactose, (3) glycerine, (4) alcohol, (5) tartaric acid. Repeated cultures have shown that the form of carbon presented produces very marked differences in metabolism, in morphology and in the changes induced by cultures upon the substratum—*i. e.*, formation of pigments, crystals, etc. These cultures emphasize the importance of exact definitions of substrata or culture media in describing saprophytes of this genus.

Plant Succession in Eastern Colorado: H. L. SHANTZ.

Climatic and soil factors of the plant habitat. Plant succession on areas which have been broken and deserted for from one to twenty-two years. Chief stages of the succession. Conditions which hasten

or retard the succession. Succession under natural conditions.

The Influence of Wind upon the Distribution of Plants in Iowa and Adjoining Territory: B. Shimek.

Winds tend to produce xerophytic conditions, and their effect in conjunction with topography and drainage, upon the vegetation of the state of Iowa, is discussed. The possibility of forest (mesophytic), as well as xerophytic areas within the state is explained on this basis.

Some Apple Leaf-spot Fungi: Carl P. Hartley.

The finding of eighteen apple leaf-spot fungi in West Virginia is recorded, the commonest ones being *Coniothyrium pirina, Coryneum foliicolum, Sphæropsis malorum,* and an undetermined species. The two first named were grown artificially. Inoculation work with both the *Coniothyrium* and the *Coryneum* indicated that they were not capable of causing serious leaf disease. Both fungi were found on wood, the former apparently wintering on dead twigs.

On the Occurrence of Pith Spots in the Wood of the Soft Maple: Hermann von Schrenk. (Read by title.)

Observations on Change of Sex in Carica papaya: M. J. Iorns. (Read by title.)

Studies in the Genus Gymnosporangium: Frank D. Kern.

This paper gives a brief statement of the problems encountered by those who began the systematic study of the genus *Gymnosporangium* in this country, with an abstract summary of the published results. The data left by past workers was chaotic and insufficient, but by selecting new diagnostic characters and by studying in detail many specimens from all parts of the United States the difficulties have been overcome. For the purpose of bringing together the data in such a manner as to be of material assistance in the determination of specimens, a key involving the characters of the telia is presented. Notes are given explanatory of changes in nomenclature, extensions of range, etc. It has been found necessary to describe three new forms.

Vernal Aspect of the Chaparral Formation of California: Pehr Olsson-Seffer. (Read by title.)

Periodicity in Spirogyra: W. F. Copeland.

The object of this paper is to mention some results of investigation bearing upon the seasonal or periodic activities of *Spirogyra.* The work was continued for twenty-two months in the laboratory and in the field. Indoor work was in ordinary biological laboratories, where over seven hundred aquaria were used. Outdoor study was limited to forty ponds within a distance of twelve miles. At least thirteen species were kept under observation. The period of maximum abundance corresponded exactly with the period of maximum conjugation. The vegetative filaments disappeared at the same time as the conjugating filaments. When a species was in fruit out of doors, it was also in fruit in the laboratory. Experiments and observations seemed to indicate that *Spirogyra* is not a perennial plant; that its activities are limited to a few weeks, or months at most; and that the vegetative and conjugating activities are conditions resulting not so much from external as from internal environment.

Types of Some Rocky Mountain Willows: Carleton R. Ball. (Read by title.)

Dry Rot of Corn and its Causes: James T. Barrett.

Diseases of ear corn which have been called "dry rot" have been found, upon investigation, to be caused by several species of fungi. The one which has been the most

destructive the past two seasons and to which 85 to 90 per cent. of the rot was due is a species of *Diplodia,* very probably *D. maydis.*

When an early infection takes place this fungus causes a premature ripening and shriveling of the ear, which usually remains in an upright position with tightly clinging and dark-colored husks. Later infections which produce various degrees of rot in the ear may or may not present the symptoms mentioned above; in fact, in many cases the disease is not detected until the husk has been removed. The seasonal infections are started by conidia blown from the old rotten ears and the one- or two-year-old stalks left standing in the field.

A form of disease which is not uncommon this season and due to a species of *Fusarium* is recognized in that it is usually more localized than that caused by *Diplodia* affecting the ears in patches. The fungus produces dense masses of mycelium both on the diseased areas of the corn and in pure culture. Microconidia are usually found in abundance, while macroconidia are rare.

A third form of the rot noticed for the first time this season is very characteristic in that infection, with few exceptions, takes place at the tip of the ear and the mycelium soon develops a deep pink color. The fungus thus far has proven to be sterile. The effect on the corn is much the same as that produced by the later infections of *Diplodia.*

Other forms of rot have been found to be due to other species of *Fusarium,* and one to one or more species of bacilli.

From data collected from fifty or more counties in Illinois in 1906, it is estimated that more than 15,000,000 bushels of corn having a value of $5,400,000 were destroyed by rot.

The Relation of "Conjugation" and "Nuclear Migration" in the Rusts: E. W. OLIVE.

The seemingly conflicting results obtained by Blackman and Christman in their investigations of the sexual phenomena in the *Cæoma* type of rusts are to some extent brought into harmony by certain new and supplementary facts recorded in the present paper.

In the several species of *Cæoma* rusts studied by the writer, fertilization was found to be accomplished, much as Christman maintains, through the absorption of a portion of the walls of two essentially similar gametes. The fusion process may begin, however, through a very small conjugation pore, so that as the one protoplast moves through the narrow opening to fuse with the adjoining gamete, the nucleus may thus sometimes be stretched out or constricted, in this condition presenting an appearance quite similar to that which Blackman has termed "nuclear migration." Such an instance is regarded simply as a case of conjugation between two cells in which the connecting pore is as yet small. The writer observed instances in which a Blackman type of conjugation, as it may be termed, through a narrow pore, occurred side by side with a Christman type of fusion, through a broad pore. The essential feature of the process is therefore regarded as the equal participation of two morphologically equivalent cells to form the binucleated "fusion cell."

But although the conclusions of Christman are thus in greater part confirmed, several observations made in connection with the sexual fusions point to the important conclusion that the two gametes differ somewhat in time of development. The observations on which this conclusion is based are as follows: (1) In the *Cæoma* forms the first hyphæ to push up under the epidermis mass themselves often more or

less regularly upright and parallel and then proceed to cut off sterile cells at their tips. The sterile tips push up against the epidermal cells and soon degenerate. A more or less prolonged period of vegetation appears thus to intervene before the conjugations begin. (2) Generally only one of the two conjugating gametes bears such a sterile tip while the other shows no such differentiation. (3) The gamete which bears the degenerating tip cell often appears to be placed somewhat above the other, thus suggesting that the earlier hyphæ fuse, not among themselves, but with other hyphæ which push up later from below. Such a differentiation in time of development does not involve, in the writer's opinion, a morphological differentiation; the lower gamete is therefore not to be regarded as a "vegetative cell." The sterile cell, according to these views, is not an abortive, functionless trichogyne, as proposed by Blackman's theory, but merely a "buffer cell," a degenerate gametophytic cell, morphologically similar to the functional gametes. This of course leaves the so-called spermatia still unexplained.

The Relationships of the Æcidium-cup Type of Rust: E. W. Olive.

The recent work of Blackman and Christman has solved to a great extent the problems which concern the origin of the diffuse *Cæoma* type of rust. But the more complicated, compacted cup fructification apparently needs further explanation. This is rendered evident by the recent discovery in a number of species of large, irregularly-shaped, multinucleated cells, which appear to arise from the stimulated growth which follows the sexual fusion. Sometimes several such multinucleated cells may be seen at the base of the æcidium cup. In some of these instances they undoubtedly originate as detached buds or branches from a single, central growth; in still other cases, more than one fusion apparently takes place and more than one center of growth thus results. It is quite probable that these large, multinucleated cells may prove to be similar to the archicarps of DeBary, Massee and Richards. The basal cells which form the origin of the rows of æcidiospores arise as the ultimate branches of the multinucleated cells.

The æcidium-cup type of rust is thus derived from a deep-seated, more or less limited, mass of cells; and the peridium arises as an enclosing layer, apparently in consequence of the deep-seated character of the fructification, as well as from its more or less centrifugal growth. The fructifying organs of the diffuse *Cæoma* type are, on the other hand, more or less superficially placed, and no peridium is formed in this instance. Many sexual cell fusions, in most instances probably one for every spore-row, occur in this kind of rust; whereas in the æcidium cup but few sexual fusions apparently take place.

The simpler *Cæoma* type sometimes shows in its course of development a phenomenon which, in my opinion, points to the conditions in which the more complicated æcidium-cup fructification probably had its origin. Following the sexual fusion, the two nuclei thus brought together begin rapidly to divide by conjugate division. Sometimes nuclear division thus goes on more rapidly than cell division; so that as a result several nuclei (as many as six have been observed) come to lie in the one large fusion cell. It is quite conceivable that a still further development of such a multinucleated fusion cell, coupled with the partial suppression of other neighboring cell fusions, especially in the case of a deeplying *Cæoma*, might give rise to the cup-shaped type of æcidium, with its enveloping peridium. This idea is made the basis of the conclusion that the complicated æcidium-cup fructification might be thus directly derived from certain of the

Cæoma-like rusts, and so to be regarded as the last of the evolutionary series of this group of fungi. While there may be some slight resemblances of the æcidium cup in its development to certain Ascomycetes, the regular occurrence of conjugate nuclei in the rust form, as well as the additional wide differences in the spore mother cells of the two groups of organisms, precludes, in my opinion, the idea of any close relationship between the two, as has been assumed by Blackman.

Are Canned Goods Sterile? T. J. BURRILL.

The canning process depends for its efficiency and safety upon the exclusion of living bacteria; sometimes by defects in the cans or in the process failure occurs. Do cans apparently sound ever contain living bacteria? Several investigators have reported affirmatively, but mistakes are hard to avoid and the reported results can not be considered conclusive.

For this investigation a new method was adopted, believed to be more likely to reach the truth, but in this there are shown to be some growths—eleven out of two thousand six hundred and one cultures or 0.42 per cent. There is every reason to believe these are contaminations in spite of the care taken to prevent them. In one case there were two positive cultures, from one can; otherwise only one tube out of seventeen from a can showed growth.

Conclusion: cans which "keep" are sterile.

HENRY C. COWLES,
Secretary pro tem.
UNIVERSITY OF CHICAGO

THE ENTOMOLOGICAL SOCIETY OF AMERICA

THE third meeting of the Entomological Society of America was held at the University of Chicago, December 30 and 31, 1907, in affiliation with the American Association for the Advancement of Science, and other societies. About one hundred were in attendance, coming from as widely remote localities as Maine and California, Ottawa and Louisiana.

On Monday sessions were held for the reading of papers. On Monday evening the annual address was given before the society by Professor Herbert Osborn, of the Ohio State University, his subject being "The Habits of Insects as a Factor in Classification." The address was followed by a most enjoyable smoker, at which the members of the society and their friends were the guests of the Entomological Section of the Chicago Academy of Sciences.

At the annual business meeting on Tuesday, December 31, the following officers were elected:

President—Dr. William Morton Wheeler.
First Vice-president—Dr. John B. Smith.
Second Vice-president—Rev. Professor C. J. S. Bethune.
Secretary-Treasurer—J. Chester Bradley.
Additional Members of the Executive Committee—Dr. James G. Needham, Professor V. S. Kellogg, Professor Herbert Osborn, Professor J. H. Comstock, Dr. P. P. Calvert, Mr. F. M. Webster.
Standing Committee on Nomenclature—(to serve three years) Dr. H. T. Fernald, (to serve two years) Professor T. D. A. Cockerell, (to serve one year) Dr. E. P. Felt.

Committee on Nomenclature.—Dr. Fernald moved, seconded by Dr. Smith:

1. That the Entomological Society of America hereby endorses the Code of Nomenclature adopted by the International Zoological Congress as the code which should be used by the members of the society so far as it can be applied.

2. That cases not covered by this code which may be presented to the society for consideration, be referred to a standing Committee on Nomenclature, to consist of three members, one member of which shall be elected each year for a term of three years, and the opinion of this committee on cases referred to them, shall be reported to the society at the first annual meeting subsequent to their reference to the committee.

Mr. Bradley moved to amend by striking out the second clause, because entomology should not be treated as distinct from zool-

ogy in general, and because the Commission on Nomenclature established by the International Congress of Zoology is the sufficient and proper body before which to bring such question for decision.

Dr. Fernald stated that the reports of the Commission on Nomenclature of the International Congress of Zoology are greatly delayed by the fact that the congress meets only once in three years, and by the rule that a question must be presented at least a year before the meeting at which it is to be considered. It was not the intention of the mover that the committee should act in opposition to or independently from the Commission on Nomenclature, but that it should be instrumental in voicing the needs of entomology before that body, which should be the final court of reference.

With that explanation, the amendment was withdrawn and motion passed.

Publication of a Journal.—Perhaps the most important act of the meeting was embodied in the following resolutions adopted by the executive committee and confirmed by the society:

1. That the society undertake a publication to be called *Annals of the Entomological Society of America*, to be issued in quarterly fascicles.

2. That it include only papers of importance or marked merit, and that each be issued and bound separately as well as in fascicles, so that each paper may be sold separately.

3. That proceedings of the meetings be included either at the beginning or end of each volume and form one separate, which is to be sent to all members of the society.

4. That a subscription price of one dollar in addition to the membership fee be charged members for the annals and that the subscription price to non-members, libraries, etc., be $3.

5. That an editorial board be selected by the executive committee and that this board shall select one of its members as managing editor, who, with his associates, shall be responsible for the selection of material to be published.

6. That if possible some one living in a suitable location and who can undertake the work of managing editor for a series of years, be selected for this position.

7. That details not covered in this report are to be determined by the editorial board.

8. That actual publication under the provisions of this report be inaugurated as soon as possible.

It will be seen from the above that all members will receive the number containing the full proceedings of the meetings free, and upon payment of one dollar the entire annals; while the regular subscription price to non-members will be $3.

A resolution was passed limiting the number of fellows for the present to ten per cent. of the membership.

The meeting then adjourned, to meet next December in Baltimore.

During the sessions the executive committee elected the following fellows: Justus Watson Folsom, William Joseph Holland, Clarence Preston Gillette, Lawrence Bruner, Mark Vernon Slingerland, Henry Clinton Fall, Charles Lester Marlatt.

J. Chester Bradley,
Secretary

SCIENTIFIC BOOKS

Practical Physiography. Harold Wellman Fairbanks, Ph.D. Pp. xxvii + 542; 403 figs., including 9 colored maps. Boston, Allyn & Bacon. 1906.

The author of this new text-book of physiography points out the fact that the evolution of better methods of teaching justifies the addition of new texts to those already in use, and in his own production makes certain departures from the usual methods with the purpose of effecting desirable improvements. Questions and exercises are distributed throughout the text, in order to make the volume a combination of text-book and field and laboratory guide. The illustrations are largely from photographs, on the ground that "they appeal with much more force to pupils of high school age than do diagrams or sketches." When diagrams are considered necessary, the student is asked to construct them. The printed illustrations are good, and have an added interest from the fact that

most of them are from the author's own negatives. The press work is excellent, and the appearance of the volume is very attractive.

The book is divided into two parts, the first supposed to deal with physiographic processes in general, and the second with physiographic features of the United States, although this scheme is not closely followed. In Part I. are considered such subjects as the general features of the earth's surface; the effect of the "interior or building-up forces" and the "exterior or tearing-down forces" on the surface of the earth; the composition of the earth; and the work of underground waters. In Part II. we find a discussion of the plains, mountains, valleys, rivers, lakes and shore lines of the United States, the climate of the United States and the subjects of forestry and irrigation, as well as a general treatment of the ocean and the air.

As a source of good illustrations and much interesting information, the book is of distinct value. While appreciating the book's many good points, the writer of this review is impelled to point out what seem to him some serious defects.

It may be doubted whether any considerable number of teachers of physiography will agree with the author that photographs can advantageously replace good diagrams. The absence of such diagrams detracts from the value of the present book. Both diagrammatic and photographic illustrations are needed in the ideal text. It is impossible to secure photographs of many things which require illustration; as, for example, the relation of structure to topography in different types of mountains. To depend upon the student for the preparation of such diagrams does not seem desirable.

The lack of system in the selection and presentation of subject-matter throughout the book constitutes, in the opinion of the reviewer, another serious defect. Physiographic descriptions are frequently encumbered with a large mass of geological details, interesting in themselves, but having little or no relation to surface forms. Two whole chapters are devoted to The Composition of the Earth. The conditions of ore deposition, and the methods of mining are of importance to students of economic geology and mining engineering; but it may be doubted whether it is expedient to burden a text-book of physiography with matter so irrelevant. The consideration of stream action, instead of being systematically presented in one place, is scattered through several chapters, especially chapters IV., The Exterior or Tearing-down Forces; VII., The Sculpturing of the Land, and XIV., Valleys and Canyons. In Part I., General Physiographic Processes, we look in vain for any discussion of such general topics as ocean tides and currents, movements of the air, formation and classification of clouds, the origin of storms, etc. But we find two chapters on these general subjects included in Part II., under the title, The Physiography of the United States. Sand dunes and glacial accumulations are treated in chapter XII., Mountains of the United States. Barrier beaches and lagoons are in part treated under Basins and Lakes of the United States, in part under The Geography of Coast Lines.

The author follows, to a limited extent, the newer method of physiographic treatment in which land forms are considered in their relation to stages of development in the geographic cycle. Such treatment is largely confined to a single chapter, where the "geographic cycle," "new topography," "mature topography" and "old topography" are briefly considered. Elsewhere in the book we find little application of this newer method, although, in the opinion of the reviewer, it is essentially important in a modern text on physiography.

When we examine the details of subject-matter we find a number of statements which many teachers of physiography would consider open to criticism. The full-bodied, subdued forms of the maturely dissected White Mountains of New Hampshire are cited as examples of "old mountains." It is implied in several places (*e. g.*, page 34) that fresh lava is always rough and old lava smooth. The implication that young mountains are those which are still being uplifted and that old mountains are those in which the uplifting process has ceased (pp. 6, 126) might

mislead the student, inasmuch as uplift might be going on in a young, a mature or even an old mountain range; while uplift might have entirely ceased in a young mountain range. The stages of mountain development are not directly concerned with constructional forces, but depend wholly upon the amount of dissection accomplished by destructional forces.

If the author's statements are correctly interpreted, it would seem that the stage of development of the land form and the stage of stream development are often confused. On page 132, after describing a region where the streams "dash swiftly through narrow canyons" and where "rapids and waterfalls mark their courses," it is stated that "the topography has now reached its *mature* stage." It is true that the land form in question may have reached maturity, but the description suggests that the streams are very young. Figure 98 represents the head of King's River in the Sierra Nevada, and is given as an example of "topography in early maturity." The mountains are mature, but the valley appears to be young. Figure 99, Trinity River in the Klamath Mountains, and figure 100, a canyon near Phœnix, Arizona, are likewise cited as examples of "mature topography," although both show features generally regarded as characteristic of youth, and both are referred to as "canyons."

The discussion of drainage patterns on pages 142–151 is confusing, because the author uses the terminology of recent students of river action, but does not follow their interpretations. The definition given of subsequent streams is not the definition generally accepted by physiographers, and the origin of subsequent streams as understood by them is nowhere referred to. The figure representing subsequent streams is misleading inasmuch as none of the streams can be regarded as subsequent, with the very doubtful exception of a few of the smallest branches. The request that the student distinguish between the consequent and subsequent streams of the folded Appalachians may lead to error, for the streams (Delaware, Susquehanna, etc.), which according to the implication of the text are to be considered consequent, are believed by those most familiar with the rivers of the region, to belong to a different class. The statement that "the tributary streams are, however, weaker than the rock structure and have adapted themselves to it," and that stream channels are "slowly shifted to correspond to the differences in the rocks" suggests that the streams, tributaries and all, are ready made, let down upon diverse rock structures, and then bodily shifted to follow the softer rocks as far as possible. The student is here given an interpretation of the methods of drainage adjustments quite different from that generally advanced to account for the relations existing between longitudinal and transverse valleys. One is surprised to find in a modern text-book the statement that when subsequent streams "encounter a broad stratum or dike of resistant rock, they turn and follow along the softer beds by the side of the main stratum until a narrow or weak spot is found in it, and then they turn and cross" (p. 145). Such an explanation is obsolete.

On page 190 we find the statement that "Plains of accumulation are distinguished by perfectly even surfaces, often many miles in extent. Volcanic plains and plains of erosion are often undulating." Maturely dissected plains and plateaus have no place in this classification, and the undulating surfaces of young plains of accumulation are not recognized. The Appalachian Plateau is not even mentioned in the discussion of plains and plateaus of the United States; nor under mountains formed by erosion, where other dissected plateaus are classed. But under Rivers of the United States, we find a brief reference to the "maturely dissected" Appalachian Plateau (p. 347). The region from the head of the Gulf of California eastward into Texas is described under Marine Plains (p. 193), where it is stated that "the waves and currents which built up these plains so long ago distributed the sediments as evenly as a floor. The mountain peaks rise like islands from this floor." The alluvial origin of extensive areas of the intermontane plains, the relations of the plains to each other and to the mountain ranges, and the many other complications

in the topography of the region, do not find a place in this description. The account of the Great Plains (pp. 212–215) leads the student to believe that the surface is a gently undulating peneplain surface with a little gravel strewn over it near the base of the Rocky Mountains; and that the eastern slope of the Rocky Mountains west of Colorado Springs is formed by the up-folded layers which underlie the plains. ("The steep slope of the eastern face of the mountains marks the point where the strata, which underneath the plains are nearly flat, have been sharply folded"—p. 214.)

The reviewer's experience as a teacher leads him to conclude that students profit more from a statement of both sides of a question concerning the answer to which some doubt might reasonably be entertained, than from a definite settlement of the question according to the author's best opinion. Some teachers would prefer to omit the consideration of such questions altogether. Teachers having either conviction will doubt the wisdom of such statements as that on page 255, where it is confidently asserted regarding a low mountain fold in Washington, that "the movement undoubtedly stopped long ago, and will never result in a greater elevation." In a reference to that problematic ring or crater known as Coon Butte, Arizona, we read: "This iron [meteoric iron found about the crater] was thought by those who found it to be fragments of an enormous meteorite which had struck the earth with such force as to bury itself deeply where the crater stands. The iron, indeed, proved to have belonged to a meteorite that by mere chance had fallen by the crater and really had nothing to do with it" (p. 268). The student would not realize, from this statement, that the meteoric origin of the crater is still maintained by competent geologists.

The author's discussion of glacial erosion includes the following statements: "It is even thought by some that the rounded canyons in glaciated areas, including the fiord canyons of Norway and Alaska, are in their essential features the work of glaciers; but there is much more reason in the view that they were made by running water, and that their flooded mouths have resulted from a subsidence of the land." "As a usual thing, the trunk stream in a given basin will deepen its channel more rapidly than its tributaries, so that the latter will for a long time enter the main canyon or valley by a rapid or waterfall. It is also true that a large glacier will erode its bed more than a small one, and this fact has given rise to the view held by some geographers that hanging valleys in glaciated regions are the result of differential action of ice streams of unequal size. From the fact that similar valleys exist in non-glaciated regions, however, it seems more reasonable to believe that the main features of hanging valleys result from stream erosion previous to glaciation" (pp. 314–316). It is to be feared that the student will here be misled as to the real reason why some geographers believe hanging valleys and fiords in glaciated regions are due to glaciation; also that he will not appreciate the very limited occurrence of hanging valleys in non-glaciated regions, or the special conditions under which they occur in such regions. He will later have to learn that, except in certain young valleys, tributaries as a usual thing enter the main stream at accordant levels, as announced by Playfair many years ago. It is interesting to note that the example of a hanging valley ascribed by the author to normal stream action (p. 330), is that of Bridal Veil Creek where it enters the Yosemite Valley; an example taken from a *glaciated* region, and believed by many to be due to glacial overdeepening of the main valley.

The antecedent origin of the course of the Green River through the Uinta Mountains is set forth without question (p. 362), notwithstanding the doubt long entertained regarding the correctness of that interpretation. The popular misapplication of the term "tidal wave" to a wave produced by an earthquake shock is adopted on page 434, without any explanation; confusion is made easy because tides are treated in the same connection. The relation of the two high tides is stated in the following words: "It (the water) is heaped up on the side nearest the moon, because there the pull of the latter is strongest; while a corresponding rise in the water takes place upon

the side farthest away, where the pull is weakest" (p. 436). While literally true, the statement is likely to mislead the student who does not notice the sudden change from "because" in the first part of the sentence, to "where" in the second part. The reason for the existence of two waves is not referred to.

Throughout the volume one sees abundant evidence of the author's extended field experience and untiring industry in collecting illustrations of physiographic features. While the book is, in its present condition, of value to teachers, for general school use the subject-matter will require, possibly in another edition, more carefully considered and systematic treatment.

D. W. Johnson

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Experimental Zoology, Vol. V., No. 1 (November, 1907), contains the following papers: "Determination of Sex in *Hydatina senta*," by David Day Whitney. "A New Explanation of the Mechanics of Mitosis," by Arthur B. Lamb. It is suggested that the characteristic configuration of the chromatin substance in dividing cells may be due to a synchronous pulsation or oscillation of the astral centers and it is shown that this explanation presents certain unique advantages as contrasted with previous explanations. "The Reactions of Planarians to Light," by H. E. Walter. The action of light upon planarians is a function of its intensity, which, under certain conditions, is emphasized by the direction of the light. The orientation and phototaxis of planarians is more consistently explained by the theory of tropisms than by the theory of trial and error. The evolution of the photoreceptive apparatus of planarians stands at such a low stage of differentiation that the light environment of these worms is of slight importance to them.

At the recent Chicago meeting of the Association of Economic Entomologists a stock company was organized for the purpose of publishing a *Journal of Economic Entomology*. This bimonthly publication is devoted to economic entomology in its widest aspects. The first number will appear in February. It has a board of editors and advisory board composed of well-known investigators. E. P. Felt, state entomologist, Albany, N. Y., is editor; A. F. Burgess, secretary of the Association of Economic Entomologists, Washington, D. C., associate editor, and E. D. Sanderson, business manager. On the advisory board are Dr. S. A. Forbes, Illinois; Dr. James Fletcher, Canada; Dr. L. O. Howard, Washington; Dr. H. T. Fernald, Massachusetts; Professor Herbert Osborn, and Professor H. A. Morgan, Tennessee.

SOCIETIES AND ACADEMIES

THE TORREY BOTANICAL CLUB

The regular meeting of the club for December 10, 1907, was held at the American Museum of Natural History at 8:30 P.M., with President Rusby in the chair and fourteen persons present. In the absence of the secretary, Mr. Charles L. Pollard was appointed acting secretary. The minutes of the last preceding meeting were read and approved.

The following scientific program was presented:

Dictionaries and their Relation to Biology: Charles Louis Pollard.

The speaker referred to the fact that a large part of the increment in our language in recent years has consisted of scientific terms, including new Latin classificatory names, biological descriptive words and phrases, and vernacular names. In spite of this there is a very general lack of interest among working scientists in the average dictionary, and it is not the indispensable reference book which it should be. The reasons for this are to be sought in the attitude of the publishers toward the style of definitions, the effort to avoid undue technicality often resulting in scientific inaccuracy. Obsolete words and meanings are frequently given too great prominence and are not properly differentiated from those in current usage. There is also a tendency to magnify the importance of so-called popular names, many of which are coined by the writers of manuals and are not used elsewhere.

The general discussion which followed brought out the fact that the dictionary, in spite of its defects, contains much information difficult to obtain from other sources, but that it is very generally at variance with usage among botanists in the matter of pronunciation.

Notes on the Pine Barrens of Long Island: ROLAND M. HARPER.

The flora of the pine barrens of Long Island has received little attention from botanists, chiefly because it consists of comparatively few and widely distributed species. A list of 46 Long Island pine-barren plants was published by Dr. Britton in 1880, and copied by at least three subsequent writers, but even yet the aspects of the vegetation have scarcely been described, or any photographs of it published in botanical literature.

The pine barrens are chiefly confined to the southern half of Suffolk County, and are very well developed in the uninhabited portions of the towns of Babylon and Islip. The area covered by them is very flat, with a soil of coarse sandy loam. The vegetation is of two types, dry pine barrens and swamps, the former being by far the most extensive. In the dry pine barrens the trees are nearly all *Pinus rigida,* and there is a dense undergrowth consisting mostly of *Quercus ilicifolia* and *Q. prinoides,* two to six feet tall. The commonest herbs are *Pteridium aquilinum, Ionactis, Cracca, Baptisia, Dasystoma,* etc. The effects of fire are everywhere visible.

In the swamps the flora is somewhat richer than in the dry pine barrens. *Acer rubrum, Nyssa, Clethra, Alnus, Myrica, Ilex, Osmunda* and *Dulichium* are characteristic. Ericaceæ and allied families are well represented.

Nearly all the species in these pine barrens are quite widely distributed in the glaciated region, or on the coastal plain, or both. Many also occur in the mountains, from New Jersey to Georgia. The vegetation is very similar to that of some parts of the pine barrens of New Jersey, from all accounts, but the flora is considerably less diversified.

The paper was illustrated by photographs, and will be published in the January, 1908, number of *Torreya.*

CHARLES LOUIS POLLARD,
Secretary pro tem.

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 409th meeting was held December 3, 1907. The president read the program for the coming academic year of the Paris School of Anthropology, and exhibited a photograph by A. Frič of a band of professional Indian-hunters still employed in South Brazil. Several of the men-hunters show wounds, while in their midst is a small group of captured Indian women and children.

Professor W. H. Holmes gave an account of the prehistoric sites in Arizona and New Mexico recently set apart for preservation as public monuments. They are great pueblos in Chaco Canyon, New Mexico; Inscription Rock near Zuñi, New Mexico, bearing autograph inscriptions of early Spanish explorers; and Montezuma Castle on the Rio Verde, Arizona. Professor Holmes was followed by Mr. Edgar L. Hewett, who presented many interesting details regarding Chaco Canyon pueblos and the cliff ruins of the Mesa Verde. Illustrations of these ruins were shown, and a prolonged discussion engaged in by Messrs. Lamb, Kober, Robinson and Hewett.

Dr. Hrdlicka demonstrated the right humerus of an adult orang showing perfect healing after a complete oblique fracture at the middle of the shaft, just below the attachment of the deltoid. The bone was somewhat shortened, but there was little displacement, leaving the animal with a very serviceable limb. The bone is from a wild orang collected in Sumatra for the U. S. National Museum by Dr. W. L. Abbott. In view of the arboreal habits of the orang, the location of the fracture in the right arm, and the time needed for a strong union of the fragments, the healing effected is truly remarkable. The case arouses much speculation as to the behavior of the animal under such conditions, and it seems certain that the injured arm was given a prolonged rest. Discussed by Professor Holmes and Drs. Lamb, Baker and Kober.

Dr. I. M. Casanowicz exhibited specimens

of ancient textiles in the U. S. National Museum. They are from Panopolis and Antinopolis in Egypt, are of linen, cotton, wool, and rarely silk, and date from the third to the seventh century, A.D. They are decorated usually in geometric designs with wool of various colors in tapestry stitch.

At the meeting of December 17, 1907, native cotton raised by the Hopi of Oraibi, Arizona, was exhibited by the secretary, who said that the seed of this cotton is similar to that found in ancient graves in northeastern Arizona. The Hopi use this cotton for cord and textiles devoted to ceremonial purposes.

The paper of the evening was by Major James Albert Clark, of the Bureau of Immigration, on "The Effects of Immigration on the Ethnic or Race Composition of our Population." Major Clark held that the pessimistic view that the country will be injured by the immigration is baseless; on the contrary, it is made by immigration. Teutonic, said Major Clark, will always be the backbone of the nation, and though 25,318,067 foreigners have come in since 1820, this number has not smothered the basic population. He discussed the various characteristics and prejudices of the racial elements which make up the American nation, and concludes that the alchemy of assimilation is forming the greatest nation the world has ever held. The address was discussed by McGee, Robinson, Hrdlicka and others, and a vote of thanks was tendered Major Clark for his illuminating treatment of his subject.

Walter Hough,
General Secretary

THE AMERICAN CHEMICAL SOCIETY. NORTHEASTERN SECTION

The eightieth regular meeting of the section was held in the amphitheater of the Chemistry Building of the Harvard Medical School, on December 20, at 8 o'clock P.M., President Frank G. Stantial in the chair. About eighty members and friends were present. The paper of the evening was by Dr. William F. Boos, of the Laboratory of Physiological Chemistry, of the Massachusetts General Hospital, who addressed the section upon "Ptomaïns and Toxins." Two classes of poisonous substances have been distinguished as occurring in the flesh of animals: (*a*) Bodies formed as the result of putrefaction, and (*b*) substances resulting from the invasion of the body by pathogenic bacteria. This distinction is being abandoned because there is really no essential difference between the two classes. Most of the substances isolated from putrid animal matter are harmless, but one, *sepsin,* is very poisonous. The term "ptomaïns" was first applied to many substances in putrefying animal matter, but most of these are non-toxic. On this account the term toxin was introduced for poisonous ptomaïns.

Toxins are classified as: (1) Ectotoxins, which are dissolved in the culture fluid, and when injected subcutaneously, produce antitoxins, which render the subject immune. The toxins of diphtheria and tetanus are of this class; (2) endotoxins, which are part of the body-substance of the bacteria, and which do not produce true anti-toxin when injected into the blood, but which yield precipitating and agglutinating agents like the opsonins of Wright. The toxin of tuberculosis illustrates this class.

Meat poisoning cases frequently occur due to toxic substances, which produce symptoms resembling alkaloidal poisoning. Thus, the toxin from infected sausages produces symptoms much like those of atropin poisoning, and has therefore been called "ptomatropin."

The only toxin which has been isolated in the pure state is "sepsin." It has been prepared from putrid yeast and putrid blood. Twenty mgms. of the sulphate killed a large dog in a few hours. The symptoms and effects are very similar to those of arsenic poisoning. By heating to 60° C., for an hour, sepsin is changed to cadaverine and rendered innocuous.

Poisoning from spoiled meat is due to sepsin; but thorough cooking changes sepsin into cadaverine. It has often been noticed in cases of epidemics, that only those who ate the smoked or lightly cooked meats were poisoned. But in ordinary cooking processes, the interior portions of the meat or fish may not reach a

temperature sufficiently high to destroy the poison if present.

As regards low temperatures and cold storage effects, the bacteria may remain alive at zero temperatures and below, and even continue to multiply as long as the medium is liquid. But if meat is stored at temperatures low enough to produce a solidly frozen substratum it will keep indefinitely since there can be no bacterial growth or activity in ice. Fowls have been found perfectly good after four years storage at —10° F. But the public prejudice against cold storage products leads the market men to thaw the birds or meat before placing them on sale. This thawing is done by soaking in cold water, and as fresh water is not used for each piece, the water becomes foul, and well preserved material becomes infected. Unsold birds or meat, after thawing and hanging in the air for longer or shorter time, are frequently returned to cold storage and re-frozen to keep until the market demands them. Such re-refrigerated stock always shows marked deterioration. By purchasing original frozen stock, and allowing it to thaw slowly in the air, the consumer can insure himself perfectly good material at practically no risk of toxic poisons. Soaking frozen stock is always to be condemned.

In the lengthy discussion it was brought out that pure sepsin always shows the same degree of toxicity, no matter how prepared. When combined with albumen, certain animal and vegetable poisons appear to act more quickly than do their pure toxins. This is true particularly of ophiotoxin or snake venom. Meats and fowl should be placed in cold storage at once after killing, to insure long keeping. But for economical reasons, the animal heat is allowed to dissipate before putting the meat in the cold room. Meats that are "high," have already begun to decompose, but their habitual use appears to render the consumer more or less immune to the effect of toxins. In support of this theory successful experiments have been made to immunize animals against sepsin.

Following the discussion, a vote of thanks to the speaker, and to the faculty of the Harvard Medical school for the courtesies extended to the section, was passed. The members were then shown through the laboratories and inspected the equipment of the Chemical Building.

FRANK H. THORP,
Secretary

DISCUSSION AND CORRESPONDENCE

TOWER'S EVOLUTION IN LEPTINOTARSA

IN SCIENCE for July 19, 1907, Professor T. D. A. Cockerell gives a very appreciative review of Tower's investigation of evolution in chrysomelid beetles of the genus *Leptinotarsa,* and incidentally points out some defects. Professor Tower's work is of such scope that it seems desirable to call attention to certain errors and shortcomings which it contains. Above all one misses a clear presentation of the facts upon which the work is built up and which alone can give it standing among scientists. The value of the evolutionary discussion, which makes up the bulk of the work, must rest upon the accurate presentation of data and if these data are weak the deductions can not hold. It is my purpose herewith to point out such statements touching upon the biology and systematic aspect of these beetles as seem to me to call for criticism. Even a slight acquaintance with the literature of the subject would have saved Professor Tower from errors which are surprising in a man who claims to have devoted eleven years to his subject.

On page 1 is a tabulation of genera and species of Chrysomelini, abstracted from the "Biologia Centrali Americana." Although this purports to include the forms found in "America north of the Isthmus of Panama" the species found to the north of the Mexican boundary, with the exception of a few species of *Leptinotarsa,* are omitted. Thus several additional genera, and a large number of species, should be included in such a consideration. It is stated that of the 13 genera enumerated all but *Phædon* are peculiar to America, while in fact *Plagiodera* and *Melasoma* are likewise circumpolar. To these circumpolar genera must be added *Timarcha, Entomoscelis, Prasocuris, Chrysomela, Gastroidea, Gonioctena* and *Phyllodecta.* Professor Tower

states that "with the exception of *Phædon*, all of these genera are closely allied." In fact, *Plagiodera* and *Melasoma* fall into a well-marked group with *Phædon*.

On page 2 Professor Tower states that three species of *Leptinotarsa* are found in the United States. The following species are known to occur north of Mexico: *decem-lineata* Say, *juncta* Germ., *texana* Schaeff. (*defecta* Linell, not Stål), *defecta* Stål, *lineolata* Stål, *dahlbomi* Stål, *haldemani* Rog., *rubiginosa* Rog.

Tower states that the life histories of *Leptinotarsa* are almost entirely undescribed; those of the following species have been published: *cacica* Stål, *behrensi* Harold, *undecim-lineata* Stål, *decem-lineata* Say, *texana* Schaeffer, *juncta* Germar, *calceata* Stål, *lineolata* Stål.

The list of the species of *Leptinotarsa* is simply garbled from the "Biologia" without reference to any other sources. Stål's classic work on the group is not even cited in the bibliography! The following two species are altogether omitted: *peninsularis* Horn and *multilineata* Stål. Most likely this last is the "*intermedia*" proposed by Tower, but not described. Under *L. defecta* at least two species are confused; quite probably the quoted record from Yucatan applies to still another species. *Leptinotarsa modesta* Jacoby = *L. behrensi* Harold, as Professor Tower might have discovered by more careful consultation of his one source of information—the "Biologia." No attempt is made to settle the status of doubtful species. Thus *L. violacesceus* Stål and *L. libatrix* Suffrian occur in the same localities and appear to be forms of one species. Tower visited these localities and collected these forms and a little attention should have settled this point. *Leptinotarsa puncticollis* Jacoby is merely a color-variant of *L. behrensi*.

Of Tower's five new species there is no descriptive matter whatever. Of four of them a single elytron is figured—however, no specific characters are shown in these figures. More useful for future identification will be the larvæ which are figured in three cases. Professor Tower asserts that the specific distinctions lie mainly in the colors of the beetles in life, and which disappear after death; he, however, studiously avoids any statement of what these color-differences are. And what are we to think, then, when on page 238 we read that *L. oblonga* is dimorphic and has a red and yellow form! In truth, several of the forms which Professor Tower enumerates as species are invalidated by the evidence which he presents in the body of the work. Thus *L. melanothorax*, if Professor Tower's observations are correct, can in no sense be termed a species; it does not exist independently in nature and is merely a color-variant of *L. multitæniata*.

While there is no direct statement to that effect, one is led to infer that the elytral pattern is of the greatest importance for specific differentiation. Yet the figures, if the forms are correctly associated, directly contradict this view. It remains to be proven, however, that such forms as appear under the same name in plate 14, Figs. 38 and 39, and in plate 23, Figs. 20 and 21, really belong together. On page 77 it is stated that the subcostal stripes are the least variable part of the elytral pattern; in *L. juncta* the two subcostal stripes present the most striking variation in that they are either independent, except at their extreme ends, or fused throughout, forming one heavy black stripe.

Plate 14, Fig. 35, shows a variation of *L. undecim-lineata* with the outer stripe wanting, but this form is omitted from the table of variation on page 78.

With Tower's seven varieties of *Leptinotarsa decem-lineata* matters stand even worse. Two of them are figured; of the rest there is nothing whatever to indicate their nature—unless one accepts the names themselves as aids to the imagination. Some of these forms are stated to show a number of characters which are specific; it would certainly be of interest to learn what these distinctive characters are. To give his work standing, Professor Tower must publish satisfactory descriptions of these forms. Furthermore, he should deposit series of all his species in a public museum, such as the National Museum, where they would be accessible to students and

their preservation and authenticity guaranteed.

Plate 16, Fig. 9, represents *L. tortusa* Tower, a "variety" of *decem-lineata;* it appears to be a sport such as is sometimes produced by malformation or slight injury to the pupa. Such oddities of color-pattern, and much more striking ones, produced in such manner, are of frequent occurrence in the Coccinellidæ.

The statements regarding the distribution of *Leptinotarsa* on page 3 are at variance with those in the table on page 1.

But it is when we come to the discussion of *L. decem-lineata,* and the book may almost be said to be a treatise on this one species, that the superficiality of the author becomes most apparent. *L. multitæniata,* which occupies central Mexico, is stated to have extended its range to the northward along with its food plant, *Solanum rostratum,* in the wake of the Spanish conquerors in their progress northward. In its new habitat (northern Mexico and Texas) it was transformed into the form "*intermedia.*" The introduction and dispersal of *Solanum rostratum* into northern Mexico along the lines of early Spanish travel, and its spread from there farther north by the bison, are discussed at great length. *L. intermedia* of northern Mexico, after it reached the eastern slopes of our Rockies, was transformed into *decem-lineata.*

The whole argument turns upon the hypothetical dispersal of *Solanum rostratum* and the assumption that this plant is the original food plant of *L. decem-lineata.* We are virtually asked to believe that since the days of the Spanish conquest *L. multitæniata* has produced the two species *intermedia* and *decem-lineata.* Professor Cockerell has made the claim that in New Mexico *Solanum eleagnifolium* is the normal food plant of *L. decem-lineata.* As Dr. Chittenden has pointed out to me, the species of *Leptinotarsa* will feed upon various species of *Solanum,* preferring the more succulent ones.

On page 24 we learn that "the original distribution of *decem-lineata* was on the eastern slope of the Rocky Mountains northward to the Canadian boundary, eastward into western Kansas and Nebraska, and southward into Texas and New Mexico. In this habitat it was found by Say in 1823. Then, as now, it was probably sparsely distributed over the area, feeding upon *Solanum rostratum.*" It would be interesting to know from what sources Professor Tower obtained all this information regarding the original habitat and food plant of the species. After the original description of the species by Say, we find the remark: "This species seems to be not uncommon on the Upper Missouri, where it was obtained by Mr. Nuttall and by myself. The variety I found on the Arkansas." The variety in question, in which "the two outer intermediate lines are united at base and tip" is undoubtedly *L. juncta;* therefore the original habitat record is from the upper Missouri only, and certainly very little was added to our knowledge of the beetle until the time when it became of economic interest.

The eastward spread of the beetle and the factors that controlled it are presented in detail. Beginning with p. 44, the effect of the wind on the dispersal of *L. decem-lineata* during its progress eastward is discussed. On page 47 it is stated that the prevailing southerly winds greatly retarded the southward progress of the beetle. The scarcity of its favorite food plant in the south is much more likely to have been a barrier to its progress. The facilities for dispersal offered by the boat traffic on the Mississippi and its tributaries (see p. 30) would more than offset the influence of the unfavorable prevailing winds.

Tower states that the species of *Leptinotarsa* are double-brooded. This point, it seems to me, needs further investigation. My own experience with species of many genera of Chrysomelidæ has shown that they are all single-brooded and that the newly developed beetles do not become sexually mature until the following season. I have had no experience with *Leptiñotarsa,* but abundant data which show that such closely related genera as *Calligrapha, Lina* and *Gastroidea* are only single-brooded. Such a physiological difference in alternating generations, of quick sexual maturity in one brood and of a long period of sexual inactivity in the other, would be

most remarkable. The seeming double-broodedness of *L. decem-lineata* may be due to the difference in the time of emergence from hibernation of different individuals. We have no exact data regarding this point in *L. decem-lineata,* but some very pertinent ones on the boll-weevil which elucidate this subject. In Bulletin 51 of the Bureau of Entomology, p. 108, it is shown that the boll-weevil continued to emerge from hibernation during a period of more than two months (March 18–May 26). It is only reasonable to suppose that there would be an equal irregularity in the time of copulation, oviposition and larval development—amply sufficient to account for the two apparent broods.

Leptinotarsa juncta is taken up on page 49, and its retreat before *decem-lineata* discussed. The original distribution of *juncta,* as given in the text and on the accompanying map, is incorrect. Originally the species extended along the Atlantic as far north as the New England states and west of the Alleghenies at least northward into Ohio. As to the present distribution, I know of its recent occurrence at Richmond, Va., New Richmond, O., and St. Louis, Mo. The observation of Professor Quaintance that *juncta* and *decem-lineata* "hybridize freely in nature, although the eggs that are laid are not fertile," is ingeniously turned to account.

"The full explanation of the extinction of *juncta* is to be found in the fact that the two species cross freely in nature, and that this natural crossing has resulted in a most interesting and peculiar case of prepotency in one species and of submergence in the other." In other words, according to Tower, *L. juncta* in crossing with *decem-lineata* has been eliminated through Mendel's law. Does Tower realize that *juncta* has a number of specific characters and that these can not all be "recessive"—at least not according to the usual interpretation of the Mendelian law? In fact, *juncta* continues to exist as a distinct species, even upon the same plant with *decem-lineata.* Furthermore, Tower states (p. 20) that his *L. oblongata* and *L. multitæniata* Stål occur together upon the same food plant but do not interbreed. The same statement is made with reference to *L. multitæniata* and *L. rubicunda* Tower. These three forms appear to be much more nearly related to each other than are *L. decem-lineata* and *L. juncta* and it is unreasonable to believe that the last two interbreed freely while the first three do not. A similar case to that of these two species of *Leptinotarsa* is that of the crowding out of *Pieris oleracea* by *Pieris rapæ. Pieris oleracea* still persists in the mountainous parts of New England, where it is found associated with *P. rapæ,* and it would be going far afield to invoke the "recessive" principle of Mendel's law to explain its disappearance from its former territory. In the Chrysomelidæ the crossing of closely related species is quite common when the two forms occur upon the same food plant. I have observed it repeatedly in *Gastroidea polygoni* and *G. cyanea,* but I am not aware that such crossing has had any appreciable effect upon either species.

In the chapter on the habits and instincts of *Leptinotarsa* we find, on page 236, the following statement: "the eggs, although they may be fully formed and fertilized, are not laid, but are retained in the passages of the female reproductive organs until they are resorbed, or, as more frequently happens, until the female dies." As the process of egg fertilization in insects is generally understood, the seminal fluid is deposited in the receptaculum seminis and the eggs are only fertilized when they pass this organ during oviposition.

The statement, on page 260, that all the species of *Leptinotarsa* feed upon Solanaceæ is certainly incorrect; this may be true of the *lineata* group, but it is certainly not for the whole genus.

Chapter III., which deals largely with the physiology of color-pattern production, is the most scholarly part of the work, and most interesting and instructive. It is, however, in great part a repetition of the previously published investigations of the author.

Many pages of the book are taken up with tables which look very impressive. As the figures are, however, for the most part only in averages, and there is nothing to show how extensive or complete are the data back of

them, they are not convincing. Thus in the table of data on page 237 relating to oviposition, the maximum, minimum and average for any given species may be made up of more or less complete observations on two beetles or on a thousand; at all events, new observations will change the figures. Data on the oviposition of *L. decem-lineata* which Mr. A. A. Girault is about to publish will change the aspect of this table very materially.

It goes without saying that there is much excellent material in Professor's Tower's work. The observations on habits are most interesting. A point well worth the attention of experimental biologists is that tropical species, being less subject to fluctuating conditions than those of more northerly regions, respond more readily to change of environment.

The work, along with other Carnegie publications, suffers very materially through the absence of an index.

FREDERICK KNAB

WASHINGTON, D. C.

SPECIAL ARTICLES

AGE OF A COOLING GLOBE IN WHICH THE INITIAL TEMPERATURE INCREASES DIRECTLY AS THE DISTANCE FROM THE SURFACE

KELVIN'S famous and epoch-making paper on the secular cooling of the earth was published in 1862.[1] His problem was to find the time which would elapse before a globe completely solid from center to surface and having throughout a certain uniform initial temperature would cool so far as to reduce the surface gradient of temperature to any given value. He assumed an initial temperature of 3,900° C., a diffusivity of 0.01178 in c.g.s. units and a final surface gradient of 1° C. in 27.76 m. or 1° F. in 50.6 feet. These data discussed by one of Fourier's theorems give for the age of the earth 98×10^6 years. Kelvin, however, expressly directed attention to the fact that the effect of temperature in modifying diffusivities is almost unknown, and that the original distribution of temperature is uncertain. He also referred to the great differences in the surface gradient of temperature, which varies with the locality, as he stated, from 1° F. in 15 feet to 1° F. in 110 feet. He, therefore, allowed very wide limits in his estimate and placed the age between 20 million and 400 million years.

In 1893 Clarence King made a very important contribution to the subject[2] by introducing the criterion of tidal stability. Mr. Barus determined for him the melting point of diabase in terms of depth. If in any hypothetical earth consisting solely of diabase the temperature in any couche were to exceed the melting point of diabase, then tidal instability would set in, the crust would break down and chaos would reign for the time being. In a real earth the same result would follow provided the couche were in a region where diabase or equally fusible rocks are to be expected. Excluding such cases, King found that the age of the earth could not exceed 24 million years when Kelvin's values for diffusivity and surface gradient are assumed. He also found that the corresponding initial temperature of such a globe would be 1,950° C.

Kelvin's last paper on a cooling earth[3] was read in 1897 and he there stated that after having worked out the problem of conduction of heat outwards from the earth by an elaborate method, he was not led to differ much from Clarence King's estimate. This he adopted as the most probable age and reduced his limits to between 20×10^6 and 40×10^6 years.

While King's earth is tidally stable, I confess that his solution of the problem seems to me to be fatally defective. He himself gives a temperature curve for the same earth at an age of 15 million years and this earth shows a couche at a temperature above the melting point of diabase, this layer extending from a depth of 34 miles below the surface to 66 miles. According to Laplace's law of densities these two levels correspond respectively to densities of 2.85 and 2.93, and it seems certain that the material must consist chiefly of basaltic rocks. Thus the 15-million-year

[1] *Trans. R. S. Edinburgh*, reprinted in Thomson & Tait, "Natural Philosophy," Pt. II., p. 468.

[2] *Am. Jour. Sci.*, Vol. 45, 1893, p. 1.

[3] *Trans. Victoria Institute*, Vol. 31, 1899, p. 11.

earth would be unstable and this instability would only just disappear at 24 million years. I am obliged to conclude that if an earth could cool in this way—if the crust could be prevented from breaking—the 24-million-year earth would only just have reached the "consistentior status" or the epoch of solidity.

The real earth, however, has been in a condition of tidal stability at least since the beginning of the Cambrian. For the strata are full of ripple marks, sands and pebbles rearranged by tidal currents, beach footprints and similar evidence of tides. Now oceanic tides would not exist upon a tidally unstable earth and therefore the consistentior status occurred long ago. It was the remoteness of this epoch which Kelvin attempted to calculate.

King gives data for only one earth which is satisfactory from this point of view. It had an initial temperature of 1,230° C. and reached a surface gradient of 1° F. in 50.6 feet in 10 million years. It was solid almost from the beginning. But apart from the excessive brevity of the age, it seems to me that this earth must likewise be rejected. The temperature was insufficient to melt even diabase a few miles below the surface, much less andesites and rhyolites, while there is a mass of well-known evidence that the earth has been fluid at least to depths of many miles from its growing surface. This is shown by the general dependence of gravity on latitude, the nearly spheroidal shape of the earth, the oblateness of the interior layers of equal density and the fact demonstrated by Kelvin,[4] Roche[5] and Wiechert[6] that a nucleus of constant high density (approximately the density of iron) surrounded by a shell of much smaller density (near 3) will satisfy the observations on precession, ratio of surface density to mean density and the ellipticity of sea level.

Considering the materials of which the earth is composed and the high pressures which must have existed at some distance from the surface at any stage of the earth's growth, it seems clear that very high temperatures must have prevailed within its mass, while for the reasons stated above tidal instability at any epoch since the ocean came into existence, is inadmissible. Hence the hypothesis of a constant initial temperature will not satisfy the conditions.

The question thus arises whether the initial temperature may be supposed to have been graduated in such a manner as to satisfy known conditions. I believe that this question may be answered affirmatively. Our great master in geophysics himself contemplated a very different distribution of temperature from the uniformity assumed in his equations. The earth, he said, "did in all probability become solid at its melting temperature all through or all through the outer layer"; "convective equilibrium of temperature must have been approximately fulfilled until solidification commenced" and "the temperature of solidification will, at great depths, because of the great pressure there, be higher than at the surface if the fluid contracts . . . in becoming solid."

If the initial temperature at the consistentior status increased with distance from the surface, it was probably according to some complex law, intimately related to that of convective equilibrium, but the thickness of the shell which has been sensibly affected by cooling is very small. At a distance of 80 miles below the surface the temperature is probably now very near 99 per cent. of what it was at the consistentior status. Hence if a layer double this thickness is considered, the conditions which prevailed in the remainder of the earth are of no consequence. The inner part, with a radius of say 3,840 miles, may have been originally at the temperature of ice or of the electric arc; it may conduct heat as well as silver or as ill as magnesia; in any case the influence on the outer surface would be insensible even after scores of millions of years. Now, though the temperature at the consistentior status did vary with distance from the surface according to a highly complex law, it is altogether probable that for so short a distance as 2 per cent.

[4] "Natural Philosophy," Pt. II., p. 420. This article also appeared in the first edition of the "Natural Philosophy," 1867.

[5] *Mém. Acad. Montpellier*, 1882.

[6] *Göttingen Nachrichten*, 1897, p. 221.

of the radius this law may be adequately represented by a straight line, the chord of an arc whose curvature is small. It would be comparable with, though not identical with, the superficial portion of Mr. Barus's nearly rectilinear curve representing the melting point of diabase as a function of depth. Hence it will be sufficient to assume that the initial temperature increased in simple proportion to distance from the surface.

It is easy to modify the Fourier equation employed by Kelvin to meet this condition. This equation is, strictly speaking, that of an infinite solid divided by a plane, on one side of which, at the initial instant, the temperature has one uniform value, while on the other side it has another uniform value. In other words, in Kelvin's problem the curvature of the earth is neglected because the phenomena are so superficial.

The equation used by Kelvin of course satisfies Fourier's law of the conduction of heat, viz.,

$$\frac{dv}{dt} = \kappa \frac{d^2v}{dx^2},$$

where v is temperature, t time, x distance from the dividing plane and κ diffusivity assumed to be constant. It follows that

$$\kappa \frac{d^2v}{dx^2} = -\frac{xV\varepsilon^{-x^2/4\kappa t}}{2t\sqrt{\pi\kappa t}},$$

and this integrated once gives

$$\frac{dv}{dx} = \frac{V}{\sqrt{\pi\kappa t}} \cdot \varepsilon^{-x^2/4\kappa t} + c. \qquad (1)$$

Here V is half the difference of the two initial temperatures at an infinitesimal distance from the dividing plane and c is a constant temperature gradient. In Kelvin's solution c is zero and the temperature on each side of the divisional plane is uniform. A second integration gives

$$v - v_0 = V \cdot \frac{2}{\sqrt{\pi}} \int_0^{x/2\sqrt{\kappa t}} \varepsilon^{-z^2} dz + cx. \qquad (2)$$

When $t = 0$, x being positive

$$v - v_0 = V + cx, \qquad (3)$$

while for negative x

$$v - v_0 = -V - cx.$$

This last equation represents the initial distribution of temperature in the hypothetical solid replacing outer space in the problem of a cooling earth. In these equations v_0 is the temperature in the dividing plane itself while V is the temperature at an infinitesimal distance from the plane at the initial instant. It is convenient to write $v - v_0 = E$ so that E is the excess of temperature of any point in the solid over the temperature in the limiting plane. For the present problem then

$$E = V + cx$$

represents the initial distribution of temperature in the earth.

If appropriate values of the constants can be found, equations (1) and (2) can be computed for any desired age and this computation is an easy task because the value of the definite integral in (2) has been tabulated by various mathematicians, the most complete table being by Mr. James Burgess and printed in 1900.[1]

Kelvin employed a diffusivity, κ, of 400, using the British foot and the year as units. In c.g.s. units this would be 0.01178. This value was obtained from experiments on the trap rock of Calton Hill, the sand of an experimental garden and the sandstone of Craigleith quarry, all at Edinburgh. Different weights were given to these observations, but how is not explained. Now, in considering the diffusivity of the earth it does not seem to me that the ragged pellicle of detrital matter on its surface need be considered. Over large areas it is absent and in most places the sedimentary rocks are saturated with water, so that their own intrinsic diffusivity is a minor feature of the flow of heat. The great bulk of the rocks in the shell affected by cooling are massive and at least comparable with the trap of Calton Hill, which is chiefly composed of Carboniferous basalt and andesite. The conductivity of this rock was observed by Forbes and Thomson (Kelvin) for no less than eighteen years, the thermal capacity was determined by Regnault, so that the value of the diffusivity, 0.00786, is undoubtedly very accurate. It does not stand alone. A com-

[1] *Trans. R. S. Edinburgh*, Vol. 39, 1900, p. 257.

mittee of the British Association,[8] Herschel and Lebour, reported for whin and traps $\kappa = .0067$, and for serpentine from .00594 to .0073, while Ayrton and Perry got for porphyritic trachyte .0103. I do not think a better choice can be made than the Calton Hill trap, and its diffusivity with the meter and year as units is the value which will be assumed here, *i. e.*, $\kappa = 24.8037$.

That κ varies with temperature and with pressure is probable. That in iron it decreases with increasing temperature is known and analogy would point to the conclusion that it should increase with pressure. Possibly diffusivity is simply related to density and for the same or similar rocks tends in the earth to a nearly constant value. At present it seems unavoidable in this problem to regard it as constant.

The outer portion of the earth is composed of various rocks which are believed to be arranged roughly in the order of density. If so the peridotites underlie the basaltic rocks, while the andesites and rhyolites overlie them. These latter are less fusible than diabase. How deep the level lies which would answer to the upper surface of the basaltic rocks can not be told with certainty. The best that can be done is to assume that Laplace's law of density is valid for a few score miles from the surface and to consider roughly the effects of heat and pressure. In this way I have reached the conclusion that at about 40 miles, or 0.01 times the radius, where the density should be 2.86, the temperature perhaps 1,300° C. and the pressure 17,400 atmospheres, basaltic rocks may begin to appear in place. A pressure of 13 or 14 atmospheres per degree centigrade is probably of the order of magnitude needful to preserve constancy of volume in a heated solid, while at atmospheric pressures the densities of basaltic rocks are from 2.85 to 3.10, with minor exceptions. I shall assume, therefore, that the outer crust to a depth of 40 miles is less fusible than basalt.

The line representing the melting point of diabase in terms of depth as determined by Mr. Barus may be taken as rectilinear for depths up to a hundred miles and is then represented by what I may call the diabase line,

$$y = 1170° + \frac{430}{.01r}x,$$

where r is the radius of the earth, and according to the results of the last paragraph the original temperature distribution in the globe must be such that only the layer of rock within 40 miles of the surface was heated to a higher point than that at which diabase would melt. Thus V being the original surface temperature and u the original temperature at distance x,

$$u = V + \frac{1600 - V}{.01r}x,$$

and this line, intersecting the diabase line at $.01r$ or 63,710 meters, must be the asymptote of the temperature excess curve.

It is easy to perceive that whatever values of the constants and the age are chosen, the temperature curve will have one and only one tangent which is parallel to the diabase line. Of course the point of tangency is that at which the curve approaches the melting point of diabase most closely or at which the additional temperature which would be required to melt diabase is a minimum. It is at this level of tangency that any access of temperature due to the dissipation of mechanical energy or to other causes is most likely to produce fusion at depths where the rock is diabasic. If the constants are assumed at any value and the courses of the curves are considered for various periods of time, it is easily seen that the point of nearest approach to the diabase line sinks to greater depths as time elapses.

Now, strains must exist in the earth at all times. They may be and are partially relieved by rupture and by solid flow, but most completely by fusion. Thus in an earth the cooling of which is represented by (2) such strains as may be incident to upheaval and subsidence and to orogeny will probably be most completely relieved at the slowly sinking surface of easiest fusion.

Messrs. Tittmann and Hayford have recently discussed the whole body of geodetic data for the United States and have shown that the deflections of the vertical are best

[8] Brit. Assoc. Ad. Sci., 1881.

accounted for by the hypothesis that isostatic compensation is uniformly distributed and is complete at a depth of 140 kilometers or 71 miles from the surface.[9]

I, therefore, adopt the hypothesis that the tangent of the temperature curve, or equation (1), is parallel to the diabase line at 140 kilometers from the surface.

V is the value of the original temperature excess of the earth at its surface over the temperature of the atmosphere in contact with it. As was pointed out above, this must have been high enough to fuse rocks more refractory than diabase and was probably about equal to the temperature of the hottest eruptions which now reach the surface of the earth. It seems to me that 1,300° is a reasonable estimate. This is considerably below the melting point of pure iron and lower than the blast furnace, but above the melting point of copper (1,065°), which lavas are known to fuse, and of Barus's diabase (1,170°). So far as I know, no precise determinations have yet been made of the temperatures at which lavas issue from their vents, though the new optical method should make good observations possible.

To take advantage of the level of isostatic compensation x in equation (1) may be put at 140,000 meters, and dv/dx at the gradient of the diabase line, or $430°/.01r$. Then with $\kappa = .00786$ and

$$c = \frac{1600° - V}{.01r} = \frac{1600° - V}{63710}$$

it follows that

$$\frac{1}{V} = \frac{1}{1170°}\left\{1 - \frac{7217.2}{\sqrt{t}\,e^{\frac{130.99\times10^6}{t}}}\right\}.$$

Although V should be about 1,300° and t might be computed as dependent variable, the form of this expression makes it easiest to assume values of t and then compute corresponding values of V and c. When these are known for any given age the corresponding value of the surface temperature gradient is

$$\left(\frac{dv}{dx}\right)_0 = \frac{V}{\sqrt{\pi\kappa t}} + c.$$

[9] Rep. to 15th general conference of the International Geodetic Assoc., Washington, 1906.

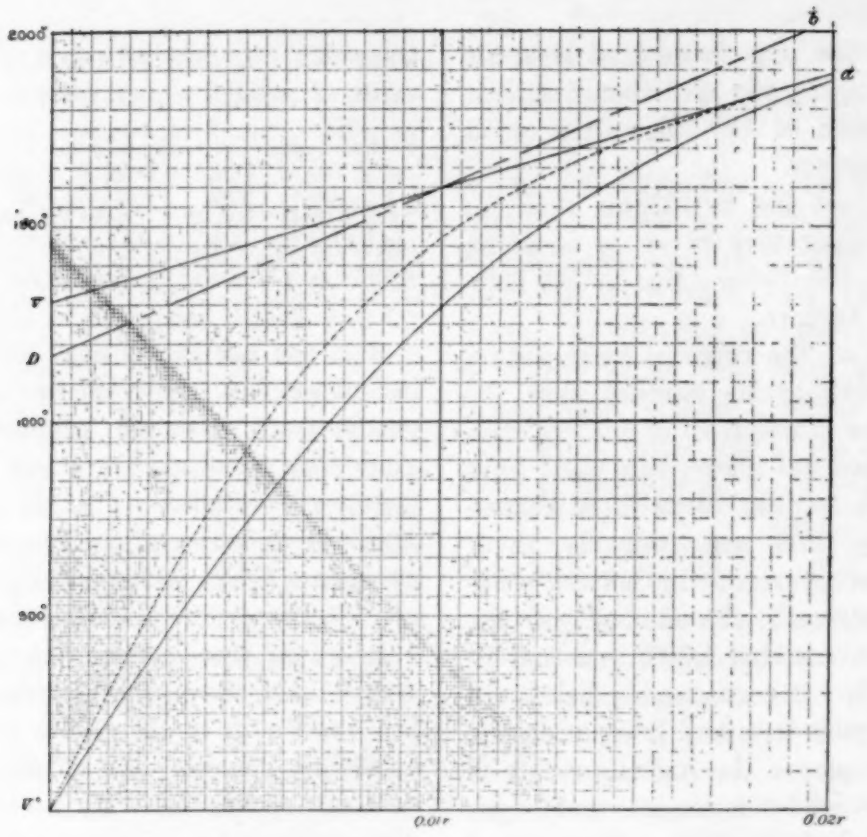
Carrying out this process I get the following table of related values:

A	30.	50.	55.	60.	65.	100.
V	1190.°	1264.	1286.	1307.	1329.	1453.
c	0.00644	0.00527	0.00493	0.00459	0.00426	0.00231
$1/c$	155.^{m}	190.	203.	218.	235.	433.
G°C.	32.^{m}2	39.2	40.7	42.2	43.6	53.3
G°F.	58.′7	71.4	74.2	76.9	79.5	97.1

A is the age in millions of years; V is the initial surface temperature; c is the initial gradient of internal temperature and $1/c$ gives this gradient in terms of meters per degree centigrade. G° C. is the final surface gradient in terms of meters per degree centigrade and G° F. is the same gradient in terms of feet per degree Fahrenheit.

In all of these earths the upper surface of the diabase couche is supposed to be at one one-hundredth of the radius from the surface, or 63,710 meters. All of the excess of temperature curves have tangents parallel to the diabase line at a depth of 140,000 meters.

Of the six earths computed the one whose initial temperature comes nearest to 1,300° C. is that of the 60-million-year earth, and it is the one which appears to me most probable. The most evident objection to it is the low surface gradient of 1° F. in 77 feet, while Kelvin took 1° F. in 50.6 feet and King stated that in 1893 the last published value as reduced from all available data by the British Association committee is 64 feet per degree Fahrenheit. King himself considered 75 feet a maximum. To me, however, it does not seem that an average value is what is required. In discussing the cooling of the earth disturbing causes must be eliminated as far as possible. Now several causes must contribute more or less to raise the temperature of rocks near the surface; for example, thermal springs, volcanic heat, the dissipation of mechanical energy by faulting or solid flow, the liberation of heat in the decomposition of minerals and radioactivity. So far as I know, the only cause which can lead to a deceptively low gradient in rocks of a given type is abnormally high diffusivity. Furthermore, to include gradients observed in sedimentary rocks seems to me to complicate the problem unnecessarily. The gradients which should



serve as a guide are those in massive rocks, especially the nearly anhydrous basaltic, andesitic and rhyolitic massives. All cases where there are local evidences of heat due to thermal springs, etc., should be excluded, and when for a normal rock the gradient is unusually high, it should be considered as suspicious. In short, for the present problem the lower gradients in massive rocks are those most likely to give a correct value of the earth's age. So far as I can judge, the gradient of 1° F. in 77 feet is not much, if at all, too low from this point of view.

The accompanying diagram represents the temperature excess curve for the 60-million-year earth as a full line. It is asymptotic to the line *Va* and involves no tidal instability. A dotted curve in the diagram shows the temperature of the same earth when 30 million years of age. At that time the level of easiest fusion, or the eutectic level, was much nearer the surface than 140 kilometers in fact at about 86 kilometers, and the increment of temperature needful to produce fusion at the eutectic level was smaller, only some 80° instead of 140° C. At no stage of the life of this earth was there tidal instability. Only in the earliest stages did the curve cross the diabase line *Db*, and that only at less than 40 miles from the surface, where by hypothesis the rocks are andesites or rhyolites and less fusible than diabase. On the other hand, the temperature of the globe at great depths is high, 2,000° being reached within a hundred miles of the surface.

Perhaps the least satisfactory of the assumptions made in this discussion is that the layer of rocks less fusible than diabase is 40 miles in thickness. To obtain an idea of the importance of an error in this assumption I have computed the gradient, assuming the refractory layer to be only 30 miles thick in the 60×10^6 year earth, the other data remaining unchanged. This calculation gives 1° F. in 79.2 feet, so that the effect of even a very large error in estimating the thickness of the refractory layer is not great.

In the course of time it should be possible to obtain better values of the constants than I have employed. I urge a careful revision of surface temperature gradients in the sense of the remarks in a preceding paragraph, accurate determinations of the temperature of lava as it flows from the vents, and above all

the study of the thermal diffusivity of massive rocks. Mr. Barus's investigation of diabase was most fruitful pioneer work and afforded the starting point for improvements which ought now to be applied to a revision of his results.

Notwithstanding the inadequacy of the data, I can not but believe that the 60-million-year earth here discussed is a fair approximation to the truth and that with better data this age will not be changed by more than perhaps 5 million years. It is in good accord with geological estimates from denudation and sedimentation, with the age of the ocean as inferred from the sodium content and with the age of the moon as computed by Sir Geo. Darwin. Finally, as I shall show elsewhere, it indicates that the part played by radioactivity in the heating of the earth is a subordinate one.

GEORGE F. BECKER
U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C.,
January, 1908

QUOTATIONS

THE GREAT BEQUEST TO TRINITY COLLEGE

BY the death without issue of Lady Pearce, who survived her husband, the late Sir William George Pearce, by less than two months, Trinity College, Cambridge, becomes immediately entitled, as we have recently recorded, to the large property in which she had a life interest. It does not often happen that the way is cleared for the owner of the remainder interest with such dramatic rapidity as in this instance. Nor does it often happen that so substantial a sum comes into the hands of any college or educational institution in this country. The total value of this bequest to Trinity College is probably considerably more than £400,000, but taken only at that figure the benefaction is an extremely handsome one. Trinity, as the most distinguished college in the two universities, is in every way worthy of this piece of good fortune, though there are doubtless many less prosperous colleges that may be pardoned for regarding it with somewhat envious eyes, and for quoting the hard saying, "to him that hath shall be given." Trinity will undoubtedly know how to make good use of the money for educational purposes; still, it may be regretted that, in view of the poverty of the university as distinguished from the colleges, some part at least of this large sum was not placed at its disposal. There are statutory provisions in force, both at Oxford and at Cambridge, whereby each college contributes a certain portion of its revenues either to some specific purpose, such as the payment of a professor's stipend, or to a common university fund to be applied to university purposes in general. Under these provisions, the university will, we presume, take its appointed toll of the Pearce benefaction to Trinity. But it is not otherwise a beneficiary. Yet in 1896 the total revenue of the university amounted to only £62,000 odd—only £844 of which was not specially appropriated—whereas in 1907 the gross annual revenue of Trinity was over £76,000.

A few comparative figures will serve to emphasize this contrast. Trinity already possesses the largest revenues of any college in the university, its gross income amounting, as stated above, to over £76,000 out of an aggregate total of £316,000 odd enjoyed by all the colleges. No doubt its outgoings and responsibilities are proportionate to this large income; but the new benefaction, probably amounting, as we have said, to considerably more than £400,000, may perhaps be taken as equivalent to an additional net income of £15,000 annually. There are no fewer than eleven out of the seventeen colleges at Cambridge of which the respective gross annual incomes amount to less than this, ranging from Magdalene with only £4,782 a year to Christ's with £14,371 a year; while a twelfth, Clare, only just exceeds it, having a gross annual income of £15,104. These figures are not cited invidiously. Their sole purpose is to show that Trinity is now about to enjoy an additional income, free of all charges, which is more than equivalent to the gross annual incomes respectively enjoyed by more than two thirds of the colleges at Cambridge. On the other hand, it is certain that at this juncture the needs and deserts of the university as

such are far greater than those of any college. For more than ten years past the Cambridge University Association has been laboriously collecting funds for the reendowment of the university and its adequate equipment to meet the educational and academic needs of the modern time. Some four years ago, on the occasion of the opening by his majesty the king of four new university buildings, the erection of which was largely promoted by this association, we published three articles by a special correspondent in which it was shown that the needs of the university, all more or less urgent and yet evaluated at a strictly moderate estimate, could not be satisfied by anything much less than a capital sum of a million and a half. It was also pointed out that the buildings of the University of Strassburg had cost nearly a million; that the state endowment of the University of Berlin was nearly £170,000 a year; that private effort had endowed the universities and colleges of the United States with more than £40,000,000 in a few years; and that in two years alone the funds obtained from this source had amounted to nearly £7,000,000. Yet at that time the Cambridge University Association had only succeeded in collecting some £71,000 in the course of seven years, a sum less than the gross annual income of Trinity by more than the gross annual income of Magdalene, and only about a sixth of the stupendous windfall which has now fallen, unsolicited and unexpected—though we are far from saying undeservedly—into the lap of Trinity.—The London *Times*.

THE GEORGE WASHINGTON UNIVERSITY

At the meeting of the Board of Trustees, held on January 8, 1908, certain recommendations of President Needham, affecting the educational work of the university, were adopted.

1. The courses of instruction in the Department of Arts and Sciences were put in charge of two general faculties; namely, the Faculty of Graduate Studies and the Faculty of Undergraduate Studies. The latter faculty is composed of all professors, assistant-professors and instructors who carry on instruction in the several undergraduate colleges and divisions.

2. In Columbian College, the B.S. degree was discontinued, and the requirements for the B.A. degree were changed so that it might cover the courses formerly embraced by both B.S. and B.A. English, mathematics and a foreign language (Latin, French or German) are specified as the required studies, constituting 9 out of 15 points for entrance, and 9 out of 60 points for the attainment of the B.A. degree.

3. In the Law Department beginning with the next academic year the requirements for the LL.B. degree are increased to fourteen hours per week, the full day work beginning at 9 o'clock in the morning. Beginning with the academic year 1909–1910, the requirements for admission to this course are two years of college work or its equivalent, with the provision that students who have not the required college work may be admitted as special students and if they obtain a record of B or better, they may be recommended for the degree. There has been established in this department for half-day students, a course of ten hours per week, covering three years, to be given between the hours of 4:30 and 6:30, and for the full course of thirty hours the degree of B.L. will be given. A four-year course of twelve hours a week will be open to students who received the B.L. degree and such students as complete the fourth year course and meet the requirements for admission and graduation will be entitled to the degree of LL.B.

4. In the Department of Medicine, beginning with the session of 1909–10, the requirements for admission will be two years of college work or its equivalent.

WILLIAM STRATFORD

Professor William Stratford, for forty-one years a member of the teaching staff of the New York City College, died on January 24. He was born at Newtown, L. I., in 1844, graduated at the City College in 1865, and took the degrees of M.D. and Ph.D. at New

York University. He became tutor in natural history in the City College in 1866, under Professor John C. Draper, whom he succeeded in 1886, as head of the department. He was a well-known member of the scientific organizations of New York, and was a recognized expert in biological microscopy, devising new combinations in the mathematics of lenses and conducting important experiments in the early days of photomicrography. In his work in the City College he introduced laboratory methods and developed its museum, enriching it with the fruits of several paleontological excursions to the Rockies. He is best known, however, as the teacher and devoted friend of those whose interests in natural history led them to carry their studies beyond the door of their classroom, and he was generous, even to a fault, in giving them his time, means, books, apparatus—all that he had. Not a few of his pupils became prominent in New York as physicians and as biologists. B. D.

MORRIS K. JESUP

IN the death of Morris K. Jesup, science in America has lost one of its wisest supporters and most liberal benefactors. Mr. Jesup's name has been closely associated in our minds with the American Museum of Natural History, and it is true that during his presidency of twenty-seven years his chief interests have been centered there, but his enthusiasm in the cause of education and of science reached far beyond the bounds of the City of New York; in fact, it is doubtful if there has ever lived in America or any other country a man trained originally for business who developed more universal sympathies and interests. The most northerly promontory of the Arctic bears his name; he was instrumental in exploration of the extreme south; as president of the Syrian College at Beirut his influence has been felt through the orient, and expeditions, made possible through his generosity, have investigated many scientific problems in the west.

There were two grandly distinctive features of his administration of the American Museum. First, his desire to popularize science through the arrangement and exhibition of collections in such a simple and attractive manner as to come within the reach and intelligence of all; second, to make the museum a center for research and an agency for the exploration of unknown fields. It may be said without reserve that he was as full of enthusiasm for, and faith in the cause of pure research as he was in that of popular education. During 1907, the last year of his administration, and with his sanction, the museum spent at least $80,000 for strictly scientific work. It is important to make this statement because the extent of the activities of the museum in the field of pure science is not so widely known as it should be.

Two years ago the trustees of the museum invited Mr. Jesup to celebrate the twenty-fifth anniversary of his presidency of the institution. A loving cup beautifully designed in gold was presented to him, with inscriptions and symbols in allusion to those branches of science in which he had taken special interest. On one face of the cup reference was made to the forestry of North America; on another, his interest in vertebrate paleontology was indicated and his gift of the Cope collection of fishes, amphibians and reptiles was mentioned; on the third face was a design symbolizing the work of the Jesup North Pacific expeditions, the last and greatest of the enterprises toward which his efforts were directed. Two years have elapsed since this memorable meeting, at which the three surviving founders of the museum, J. Pierpont Morgan, Joseph H. Choate and Mr. Jesup, were present.

It is not possible to review or summarize here all the different directions in which Mr. Jesup was led by his keen sense of the duties of citizenship. He was a man who had a strong civic pride; he believed in American ideas and in American men, and was ever willing to sacrifice his own interests to those of the community. He was an idealist, an optimist, and keenly patriotic. He was sanguine, determined, forceful, trustful, appreciative and even affectionate toward those closely associated with him. Many of his acts of kindness will never be known, because hundreds of his deeds were on the principle of not letting the left hand know what the right

hand doeth. As a merchant and banker he was successful, and the culmination of his business career was reached when he was elected to the presidency of the Chamber of Commerce. Through his activity this stately association of the merchants of New York was provided with its present magnificent building. This reminds us of another aspect of Mr. Jesup's life—his desire that science and commerce should both be set amidst appropriate and dignified surroundings.

During the past year, because of failing strength, Mr. Jesup has not been able to take an active part in the management of the museum, but its welfare has been one of the chief subjects of his thought and its progress one of the chief sources of happiness to him during the long suffering days and weeks of his illness. Born at Westport, Connecticut, June 21, 1830, he passed away in New York City on January 22, 1908. His death has been followed by rare testimonials of admiration and appreciation.

H. F. O.

SCIENTIFIC NOTES AND NEWS

Professor Reginald W. Brock, professor of geology in the School of Mining, Kingston, has been appointed director of the Geological Survey of Canada.

Dr. Arthur Newsholme has been appointed medical officer to the London Local Government Board on the retirement from that office of Mr. W. H. Power, C.B., F.R.S.

Mr. R. H. Lock, fellow of Gonville and Caius College, Cambridge University, has been appointed an assistant director at the Royal Botanic Gardens at Peradenyia, in Ceylon, a post which, at the instance of the director, Dr. Willis, has been created for him by the Colonial Office.

Dr. Theodore W. Richards, professor of chemistry at Harvard University, has been elected a foreign member of the Academy of Sciences at Stockholm.

Dr. Feodor Cernyshev, St. Petersburg, has been elected a foreign correspondent of the Geological Society of London.

Mr. C. O. Waterhouse has been elected president of the British Entomological Society.

The senior students in mining at the Pennsylvania State College have presented to Professor M. E. Wadsworth, dean of the schools of mines and metallurgy, a silver loving cup on the occasion of his sixtieth birthday.

Professor J. Paul Goode, of the University of Chicago, will spend the next six months at Washington in order to use the geographical works in the congressional library.

Dr. W. W. Beman, professor of mathematics at the University of Michigan, has been granted leave of absence for the coming academic year, which he will spend abroad.

Mr. R. S. Williams, assistant curator of the New York Botanical Garden, has gone to the Isthmus of Panama to make collections for the garden. He expects to return in May.

The *Koonya* has returned to Wellington, N. Z., after having towed the *Nimrod,* Lieutenant Shackleton's ship, with the British Antarctic Expedition on board, 1,500 miles to within a mile of the ice.

We learn from the London *Times* that the Aéro Club of France gave a banquet on January 16 to Mr. Henry Farman in honor of his feat in winning the prize offered by the club for the first flight of one kilometer with a machine heavier than air. The chairman, in proposing the toast of the guest of the evening, recalled the history of the conquest of the air. The Comte de la Vaux then presented the gold medal of the Aéro Club to Mr. Farman, who also received two other gold medals, one from Messrs. Voisin, the builders of his aeroplane, and the other from M. Frank Reichel, as well as a bronze by Barrias, presented by M. Robert Esnault-Pettrie, of the Académie des Sports. M. Le Vasseur was presented with a medal in enamel by Messrs. Voisin. Speeches were then made by M. Henry Deutsch, Baron de Zuylen, M. Archdeacon, Prince Roland Bonaparte and Mr. Henry Farman, after which MM. Deutsch and Archdeacon each handed a cheque for 25,000 f. to Mr. Farman.

THE prize of £50 from the Gordon Wigan fund, Cambridge University, for an investigation in chemistry was awarded in the year 1907 to F. Buckney, of Sidney Sussex College, for his essay entitled "A Study of some quinquevalent cyclic nitrogen compounds."

MR. BAILEY WILLIS, of the United States Geological Survey, will give a series of six lectures at the University of Illinois from February 10 to 15. Most of these lectures will deal with the past and present geography of North America. In one Mr. Willis will give an account of his recent geological experiences in China.

PROFESSOR ROLLIN D. SALISBURY, University of Chicago, and Dr. H. Foster Bain, state geologist of Illinois, will give special lectures in geology at the University of Wisconsin during the present year.

THE sixth lecture in the Harvey Society course will be given by Professor Joseph Jastrow, University of Wisconsin, at the New York Academy of Medicine building, on Saturday evening, February 8, at 8:30 P.M. Subject, "Subconsciousness."

THE experiment of Foucault, originally performed in the Panthéon at Paris in 1851 to prove the rotation of our earth, will be repeated twice publicly at Columbia University in St. Paul's Chapel. The apparatus includes a pendulum, 91 feet long, of which the weight is a cannon ball weighing 140 pounds, the whole suspended within the chapel dome. The time required by this great pendulum to complete a swing is six seconds. Two half-hour lectures in explanation of the experiment will be given as follows: February 7, Dr. S. Alfred Mitchell, at 3 P.M., and February 12, Professor Jacoby, at 4:30 P.M. Visitors will be admitted to see the swinging pendulum until 5:30 P.M. on both days.

A BILL has been introduced in the senate by Senator Teller, for the erection of a memorial to John Wesley Powell, director of the Bureau of American Ethnology and the U. S. Geological Survey.

A LIFE-SIZE bronze bust of the late Professor von Bergmann was presented last month, as we learn from the *Journal of the American Medical Association*, to the clinic, the scene of his surgical triumphs, by his former pupils, many of whom now occupy prominent positions in other clinics. The bust stands beside those of Gräfe, Dieffenbach and Langenbeck. Professor Bier, the present chief of the clinic, and Professor Sonnenburg delivered addresses.

SERVICES in honor of the late Nicholas Senn were held in the Fine Arts building, Chicago, on February 2, under the auspices of Rush Medical College, Northwestern University Medical School, College of Physicians and Surgeons, Chicago Medical Society, Chicago Surgical Association and the Nicholas Senn Club. President Edmund Janes James, of the University of Illinois, was chairman, and the speakers were: Dr. Frank Billings, dean of Rush Medical College, "Nicholas Senn as a Teacher"; Dr. Arthur R. Edwards, dean of Northwestern University Medical School, "Nicholas Senn as a Scientist"; Dr. William E. Quine, dean of the College of Physicians and Surgeons, "Nicholas Senn as a Man"; Dr. Henry B. Favill, president of the Chicago Medical Society, "Nicholas Senn as a Physician"; Dr. Albert J. Ochsner, president of the Chicago Surgical Association, "Nicholas Senn as a Surgeon," and Dr. Daniel R. Brower, president of the Nicholas Senn Club, "Nicholas Senn as a Traveler."

MR. CHARLES ABBOTT DAVIS, curator of natural history at the Roger Williams Park Museum, Providence, died, on January 29, at the age of thirty-nine years.

CAPTAIN JULES BAILLY, osteologist at McGill University, known for his work in osteology and natural history, died, on January 29, at the age of seventy-seven years.

DR. A. WILLIAMS WILKINSON, a chemist in New York City, known for his inventions in connection with illuminating gas, has died at the age of seventy-five years.

DR. H. G. KNAGGS, a British medical man, known for his contributions to entomology, died, on January 16, in his seventy-sixth year.

Mr. John Macfarlane Gray, the well-known British engineer, died, in Edinburgh on January 14, in his seventy-sixth year.

There will be civil service examinations on March 4 and 5 as follows: Statistician in the Geological Survey, three vacancies at salaries from $1,200 to $1,800; assistant geologist, qualified in petrology, at $75 a month, a temporary position, but qualifying for promotion; aid in the Bureau of Standards, at a salary of $600; executive assistants in the Bureau of Plant Industry, at salaries ranging from $1,600 to $2,000, there being at present vacancies in connection with tobacco investigation and in the office of the cerealist; and food and drug inspectors, at salaries from $1,000 to $1,800 in the Bureau of Chemistry, Department of Agriculture.

By the will of the late Morris K. Jesup an endowment fund of $1,000,000 is given to the American Museum of Natural History, of which he had been president since 1882. The provision of the will relating to the museum is as follows:

I give and bequeath to the American Museum of Natural History in the city of New York $1,000,000, to constitute a permanent fund, the principal to be invested and kept invested, and the income to be applied and apportioned to the general purposes of the museum, other than alterations, additions, repairs or erection of buildings, the purchase of land, or the payment of salaries, or for labor or for services of any kind ordinarily considered under the item of maintenance. I wish to explain that I have bequeathed this sum of $1,000,000 to the American Museum of Natural History and that I have made for it the other bequests and provisions contained in my will because of the fact that I have been identified with the museum from its act of incorporation to the present time. I have been its president since 1882. Since that time I have devoted a great part of my life, my thoughts, and my attention to its interests. I believe it to be to-day one of the most effective agencies which exist in the city of New York for furnishing education, innocent amusement, and instruction to the people. It can be immensely increased in its usefulness by increasing its powers. The city of New York under its contract with the museum is to provide buildings and to maintain them, but the buildings must be filled with specimens. This means that for this purpose the necessary amount must come from individual donors. It is in order that the means for this purpose may be helped, as the museum must grow in additional buildings by the city, that I make for the museum the bequests and provisions contained in my will, relying upon the trustees of the museum to do their share by looking after the investment of the funds, the use of its income, and by carefully watching over and wisely planning for the best interests of this great institution.

The anthropological collections made by Mr. Henry G. Bryant among the Esquimaux, have been presented by him to the University of Pennsylvania.

Professor Hirschberg has informed the authorities that his will presents his valuable collection of ophthalmologic works to the Berlin Royal Library with an endowment of about $4,000, the income of which is to be applied for subscriptions to the current periodicals on ophthalmology and optics.

In its recent report to the government the Swedish Commission for the Prevention of Tuberculosis recommends the gradual establishment of 4,600 sanatoria at a total expense of 10,810,000 crowns. It is proposed that the expenses of patients shall be paid by the municipalities.

A conference of the district engineers of the water resources branch of the United States Geological Survey was held at the office of the Survey in Washington during the week ending January 25. Those present were: W. B. Clapp, of Los Angeles, Cal., in charge of the California district; J. C. Stevens, of Portland, Ore., whose district includes Oregon and Washington; Robert Follansbee, of Washington, D. C., in charge of the district covering Montana, North Dakota and a portion of northern Wyoming; W. B. Freeman, of Denver, Colo., supervising work in Colorado, Nebraska, Oklahoma, New Mexico and southern Wyoming; E. C. LaRue, of Salt Lake City, whose district is Utah, Idaho and Nevada; H. K. Barrows, of Boston, in charge of the New England district and New York; M. R. Hall, of Atlanta, Ga., in charge of the work in the South Atlantic and Gulf States; and J. C. Hoyt, assistant chief hydrographer, who

supervises from the Washington office the work in the Middle Atlantic States. Other engineers present were C. C. Covert and F. W. Henshaw, of the Washington office, recently engaged in stream measurements in Alaska in cooperation with the survey's Division of Alaskan Mineral Resources; R. H. Bolster and W. G. Steward, also of the home office; F. W. Hanna, of the U. S. Reclamation Service; and Sydney K. Clapp, of the Board of Additional Water Supply for New York City. The meeting was presided over by the chief hydrographer, Mr. Marshall O. Leighton. The subjects under discussion included methods of work, instruments and equipment, scientific studies, storage and evaporation investigations, cost-keeping systems, and publicity and cooperation work. Special addresses were made by the director of the survey, George Otis Smith, and by Dr. G. K. Gilbert, who explained in detail the methods of investigation of what is known as the "débris problem" of California rivers, now in progress at the hydrologic laboratory of the survey, at Berkeley, Cal.

THE London *Times* states that in a recent German patent a method is described for producing artificially certain mineral species, such as olivine, zircon, beryll, and spinelle, in a definitely crystalline form. This consists in dissolving their constituent oxides in appropriate proportions in molten sodium or potassium metaborate. The temperature of the fused mixture is then raised to 1,300° C., when the alkali metaborate volatilizes, leaving the artificial mineral in the form of crystals. In addition to obtaining products corresponding with the naturally occurring minerals, other compounds having no mineralogical counterparts may be produced by this method. A nickel chrome spinelle, NiO, Cr_2O_3, prepared from its constituent oxides, was obtained in the form of small green crystals. It is well known that the mineral species corundum occurs in the form of very variously colored stones ranging from colorless sapphire to brown and opaque corundum. Between these extremes one meets with sapphires tinted in yellow, green, blue, red, and intermediate hues, and it is generally supposed that these various colors are due to the presence of compounds of iron, manganese, chromium, titanium, or other foreign elements. In the *Comptes rendus de l'Académie des Sciences* F. Bordas describes experiments in which the color of these gems is caused to change by exposing the stones to the action of a very radioactive specimen of radium bromide. In these circumstances a blue sapphire assumes successively green, light yellow, and dark yellow tints, whilst a red sapphire develops in succession shades of violet, blue, green and yellow. These experiments justify the belief that the distinctive colors of these precious stones are not due to the presence of any particular oxides. The variation always occurs in the above sense from red to yellow, and it seems likely that the topaz represents the last term in this transformation. Moreover it seems probable that these gems are found in regions where the surrounding soil has a certain degree of radioactivity. This idea receives support from the fact that the yellow sapphires are the commonest, although yellow and blue sapphires frequently occur together. The gems which have been thus artificially colored are not radioactive; they do not become luminescent in the dark under the influence of radium bromide, but they retain their color on heating.

Nature states that an addition to the exhibition galleries of the British Museum (Natural History) has been made in the shape of a copy of a water-color drawing made about 1585 by John White, containing the earliest known representation of the American king-crab, *Limulus polyphemus*. John White, who was one of the first settlers in Virginia, of which he was for some time governor, served as lieutenant to Sir Walter Raleigh. In three volumes of drawings by him preserved in the department of prints and drawings in the British Museum, many of the delineations of natural objects are of great beauty, and show a fidelity to nature rare at the period. The drawing in which the king-crab is depicted was engraved, with some modifications, for de Bry's "America" ("Grands Voyages," Part I., pl. 13) in 1590. In the engraving the king-crab is, however, shown in somewhat

greater detail, thus suggesting that the engraver had an actual specimen or another drawing from which to copy.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. Lawrence introduced in the House of Representatives on January 27 a bill to create a commission to investigate and report to congress as to the advisability of the establishment of a Pan-American University. It was referred to the committee on education.

The regents of the University of Michigan have appropriated $275,000 for the new chemical building, which will be erected as soon as possible on the north side of the campus. It will consist of four stories and a central court, being built on the same plan as the new medical building.

According to the *Journal of the American Medical Association* the contract for the building of the new Richardson Memorial Building, Tulane University, has been let. The new building is to cost about $200,000 and will be three stories and a basement in height. The basement will contain workrooms for minor surgery, original research and toilet and storage rooms; the first floor will have a large lecture room and physiologic and pharmacologic laboratories, and also the administration offices; the second floor will contain pathologic, bacteriologic and histologic laboratories, private laboratories for the professors and research rooms; the third floor will contain the dissecting room, anatomical museum and laboratories for the curator of the museum and the professor of anatomy, research rooms and also a large lecture room. The building is expected to be ready in October next.

The last legislature of Pennsylvania appropriated $50,000 for the School of Mines and Metallurgy of the Pennsylvania State College, of which sum $20,000 were for further extension of its buildings and $30,000 for its maintenance. The buildings, as planned and partly built and occupied, contain over 60,000 square feet of floor space. The buildings contain laboratories and lecture rooms, for the instruction in crystallography, mineralogy, petrography, geology, mining geology, metallography, metallurgy, assaying, ore dressing, coal washing, mining, etc. Among the recent appointments are these: Clarence P. Linville, assistant professor of metallurgy; Frank A. Dalburg, instructor in mining and metallurgy; Lloyd B. Smith, instructor in mineralogy and geology, and Howard I. Smith, instructor in mineralogy and metallurgy.

The trustees of Boston College, an institution in charge of the Jesuits, have acquired thirty-three acres of land near the Chestnut Hill Reservoir in Boston, for a new site for the college. The site is said to be one of the finest in New England for educational purposes. It has been suggested that the initial plan should contemplate the erection of a recitation building, an administration building, two science buildings, a gymnasium, a library and a college theater. Work is to begin at once.

The sum of $50,000 has been collected for Illinois College at Jacksonville, Ill., which makes available the $50,000 offered on this condition by Mr. Andrew Carnegie.

New four-year courses in chemistry designed to train analytical chemists, industrial chemists, agricultural and soil chemists, sanitary and food chemists, and physiological chemists have just been arranged by the faculty of the University of Wisconsin.

The Harvard Faculty of Art and Sciences has passed the following resolution:

> At the last meeting of the faculty of arts and sciences it was voted to send to the president and fellows of Harvard College, the committee on athletic sports, and to each college represented in the Association of Colleges of New England, the following expression of opinion: "That in the opinion of this faculty the number of intercollegiate contests should be largely reduced."

Dr. G. M. Stratton, professor of experimental psychology and director of the Psychological Laboratory at the Johns Hopkins University, has accepted the chair in psychology in the University of California.

Professor Jungfleisch has been called to the chair of chemistry in the Collège de France, vacant through the death of M. Berthelot.